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STEAM TURBINE WEAR.

The steam turbine although comparatively a new applicant for central-station honors has been received with enthusiasm, and is now accorded a prominent position in that field of usefulness. That many mechanical engineers have confidence in it is proved by the number of enormous electric generating stations now being erected, in which this engine will be the prime mover.

Although the principle is not new, there are not many turbines of the recent improved types which have been in service long enough to prove their freedom from wear. Hence every bit of evidence which can be obtained on successful turbine operation is eagerly sought. Some information on this subject is given in a brief article by Mr. J. R. Bibbins in the June issue of the *Electric Journal*. Mr. Bibbins describes conditions of a Westinghouse-Parsons turbine which was installed in the plant of the Westinghouse Air Brake Company, and which has been in continuous service there for nearly six years. The machine is rated at 400 kilowatts and was installed in August, 1899. It was opened in March of the present year. It was found that the vanes had suffered little or no wear. They had maintained their full cross-section, and consequently their full mechanical strength. And the vane angles were unimpaired, and hence their efficiency not decreased. The working surfaces were also smooth. This is in spite of the fact that the steam supplied to these turbines is frequently wet. At times, even water was carried over into the turbines. Moreover, it is said that not infrequently the purity of the feed water was in question. It is significant that these results have been obtained with one of the early turbines, for six years have resulted in great improvements in the design and manufacture of these engines.

HIGH-SPEED TRAINS.

The decision of the New York Central & Hudson River Railroad Company to establish a nineteen-hour train between New York and Chicago has spurred the Pennsylvania Railroad to an increased effort. The latter road will attempt to maintain an eighteen-hour schedule between these two cities, and to test the practicability of doing this, a run was made on June 5, in which the distance was covered in sixteen hours including all stops. This gives an average speed of a little less than fifty-six miles per hour. To maintain an eighteen-hour schedule, instead of one which requires twenty hours, will impose a greatly increased strain upon all who are responsible for the safety of the passengers and the schedule; but the passengers themselves will hardly realize the additional effort required to cut down the running time ten per cent. Now the New York Central has announced that it will also run an eighteen-hour train between the metropolis of the East and that of the West.

As each road thus redoubles its efforts to keep ahead of the other, one wonders whether these exceptional trains are really profitable, or, at least, as profitable as the regular trains; or whether it is the advertising which is being sought. Is it done merely to enable the road to say that it maintains the fastest schedule?

In either case, one wonders how far this competition will be carried, and whether it will eventually lead some road to build a high-speed electric line. If high speed is sought for its own sake, the electric motor should soon come into its own. If, on the other hand, it is merely advertising, the electric system should be a trump card.

SLOW PROGRESS IN TRAIN LIGHTING.

In a report presented by Mr. Charles B. Dudley, of the Pennsylvania Railroad, to the International Railway Congress, which met recently at Washington, D. C., the present status of various systems of railway car lighting is considered. The tendency seems to be toward an increase in the use of com-

pressed oil gas, and away from the use of compressed coal gas. One difficulty in the use of coal gas is the loss of illuminating power due to the compression, and the small number of hours of light which can be supplied with one charging. In an effort to prolong the life of the compressed coal gas system it is sought to use Welsbach mantles on the cars. This would remove the objection to the loss of illuminating power; but, as yet, the experiments have not shown that Welsbach mantles can be burned successfully under railway conditions.

The increase in the use of compressed oil—by which is meant an illuminating gas formed by passing air through volatile oil—is attributed to several causes. A quantity sufficient for a number of days can be introduced at one charging, and there is no loss of illuminating power due to compression. Furthermore, for branch lines or lines where it is not convenient to install charging stations, the carbureter system may be used. The advantage of this is that the same lamps are used, and a charge will last a number of days. In this system the oil is placed in a carbureter—a vessel filled with some absorbent material—and air at a reduced pressure, drawn from the air-brake supply, is passed through. The system is simple and gives a good light, as gas lights go. Acetylene is used to a slight extent, but is not free from serious objections and dangers.

It is somewhat disappointing to be told that electric lighting of trains is making but slow progress. There are a number of through trains fitted with electric lights which draw current from a small generator driven by a steam engine. The objection made to the simple storage battery system is the rapid deterioration of the batteries. Another electric system which is tried more or less is that in which each car contains a complete equipment of dynamo, storage battery and lights. The principle of this system seems to appeal to the railway engineer; but, from what we can learn, he is demanding apparatus which will give results comparable with those obtained from a good electric light station, yet he insists upon having apparatus so rugged that it will require no expert attention. Give him a car-lighting system which he can put under his cars and inspect once, say, in six months, and he will consider it. But it is rather difficult to devise apparatus which will regulate within two per cent for all variations of speed and load, and which can be looked after by the air-brake inspector with no other tools but a crowbar and a monkey-wrench.

The advantages of the electric light are so evident that it would seem worth a greater effort on the part of the railway engineer to test out different systems, and to assist in this way in developing a satisfactory one. So far as securing the best results is concerned, no other method can be compared with the electric, and in case of accident it does not introduce any danger. On the other hand, that the gas-lighting systems are hazardous has been only too well demonstrated within the last few months by several bad railway accidents, in which the horror of fire has been added to that of collision. Although it is admitted that the outlook for the electric systems is hopeful, we wish that we could see, in the near future, the end of the gas-lighting systems.

WIRELESS IN WAR.

Last week attention was called to the practical use of wireless telegraphy by the great Atlantic liners—an application which adds much to the safety and comfort of ocean travelers. Now it seems that wireless telegraphy played a most important part in the recent naval battle in the sea of Japan, and that the victory for the one side was contributed to largely by the excellent use which that side made of its wireless apparatus.

While detailed accounts have not yet been published, from a careful reading of those which have been given out it seems that Admiral Togo, while remaining at his naval base with his fleet, was kept constantly informed of the approach of the Russian fleet by means of the wireless apparatus carried by his scouts. In this manner he learned not only the course which they were following, but their position, and thus was enabled to make his attack somewhat in the nature of an ambush. He was able to time his movements so as to attack just when and where he thought best. Although the Russian fleet had some wireless apparatus, it was not in a position to make as good use of it as the Japanese; and although they were no doubt expecting battle, the actual attack must have come somewhat as a surprise.

It seems, however, that Admiral Togo did not confine his use of wireless telegraphy to scouting. The fleets engaged were large, and the line of battle was long. The day was foggy, so that visual signals could not be read far. Admiral Togo's wireless system, however, gave him a means of transmitting orders to any vessel, and thus of fighting a fleet action. Had this not been possible, the battle might have turned into a number of boat-to-boat engagements, with the probability of a greater number of Russian vessels escaping. It will be most interesting to learn later on—as we doubtless shall—just how serviceable the wireless system proved to be during a tremendous battle. The ships must surely have been in such a state of uproar and vibration, and the men under such a strain that a successful use of wireless there might be considered a supreme test of its capabilities.

LIGHTNING PROTECTION.

Two reports have been made recently on the subject of lightning protection. The first gives the results of the lightning research committee, which was organized some years ago by the Royal Institute of British Architects and the Surveyors' Institution. This report deals principally with the protection of buildings. The second report referred to above was presented at the recent meeting of the National Electric Light Association, at Denver, by Mr. Alex Dow. It deals with the protection of electrical systems from lightning. In neither report is there any particularly novel suggestion, nor have the investigations brought to light any new phenomena. Previous recommendations are upheld by the new evidence secured by the members of the committees.

The report of the British research committee is preceded by an introduction prepared by Sir Oliver Lodge, a member of the committee. In this introduction he considers two types of

lightning stroke. The first, termed by him the A stroke, is one in which a direct discharge takes place from a charged cloud to the earth. This discharge is not particularly dangerous. To protect buildings from it, lightning rods are useful. The points of the rods may indeed prevent a violent discharge by assisting in equalizing the potentials of the cloud and the earth. Lightning rods, to be effective, must, however, be installed properly. They should offer a path of least resistance for the discharge, yet the resistance of this path must not be too small. If the rod does not form the path of least resistance, the discharge may leave it and find its way to ground through neighboring materials. On the other hand, if the resistance of the rod be too low, the discharge takes place through it too rapidly—almost explosively—and is liable to set up induced or secondary discharges in neighboring conductors. The rod should be carried to the ground with as few bends as possible. Iron is a better material than copper, provided atmospheric conditions are not such as to rust it away too quickly.

The other, or B type of stroke, as it is called, occurs when an uncharged cloud intervenes between the earth and the charged cloud. This intervening cloud acts with the charged cloud as an electrical condenser, and when a discharge takes place between them, the charge upon the upper surface is neutralized, and that on the lower surface suddenly set free, and consequently throws a sudden strain in the dielectric between the cloud and the earth, with the result that if a discharge takes place, it is apt to follow an erratic path. The effect of such strokes is more serious than that of an A stroke, and lightning rods offer but slight protection. The only way to protect the building from such strokes is to surround it by a cage of metal. It is suggested that powder magazines be protected by a complete metallic sheathing; but even a metallic cage does not guarantee a building against lightning.

Lightning will sometimes prefer to find its way to ground through the hot gases of a tall chimney, rather than through the rod provided for it. It is suggested that this might be prevented by raising a number of rods well above the top of the chimney, connecting them to the ground through vertical wires. It is recommended that all metallic parts of a building be connected to good grounds; and although there is no record of damage to tall steel-frame structures, it would be desirable to provide a better earthing connection than that usually obtained through the concrete foundation. The report suggests that the usual method of grounding conductors by means of large plates should be abandoned in favor of a ground obtained through a perforated steel spike driven into moist ground, and filled with granulated charcoal (not coke).

The problem presented to electrical engineers is in some ways even more troublesome than the protection of buildings from lightning, for in addition to providing a path for the discharge to ground, the lightning arrester must prevent the line current from following along the path taken by the lightning. In addition, lightning arresters used on electrical systems are frequently depended upon to protect the system from damage due to an unexpected happening taking place on its own lines. A short-circuit on a transmission line, or a sudden throwing off of a large load, may set up electrical oscillations which will cause an excessive rise of voltage, with danger of breaking down the insulation of the electrical machinery. If the lightning arrester be adjusted so as to allow a discharge to take place if the voltage not only from the lines to the ground, but between the lines themselves, rises above a certain point, it will act as a safeguard. The engineer of a transmission system does not fear a direct stroke of lightning as much as induced or secondary strokes, or excessive potential due to a static charge. A direct stroke will frequently find its way to ground through the poles, rather than pass back to the station over the line. The pole may be shattered, but the system otherwise will be undamaged. A conducting line may, however, be brought to a high potential by unsuspected causes—high winds, dust storms and other atmospheric occurrences—which will throw a dangerous strain upon the electrical machinery. To protect the system from this danger the arresters must provide a path which can be taken by the charge. Such a path is, in general, one of high resistance, and may be formed of a number of small air-gaps, of water jets or carbon rods, or a combination of such devices. In this country the greatest dependence is placed upon an arrester which combines a spark-gap and a conductor of high resistance The gap or gaps are proportioned so as to prevent arcing due to the line potential, but to allow an arc to be established if the voltage rises above a certain limit. Once this has happened and an arc formed, the resistance of the gaps is reduced, since heated air is a better conductor than cold air; and the line voltage will, in general, be sufficient to maintain an arc if means are not provided for breaking it. This may be brought about by blowing out the arc by an electromagnet, or by arranging the path to ground in such a way that, after the arc has been established, the voltage across the spark-gaps falls so low that the arc can not persist.

To protect electrical systems from lightning, it is sufficient, according to Mr. Dow's report, to protect the stations and let the line take care of itself—that is to say, in a transmission line there is need for arresters only at the generating and receiving stations. A distributing system should be protected wherever machinery is installed—that is to say, at every consuming point.

The characteristics demanded of a lightning arrester in Mr. Dow's report are these: it should discharge at a potential slightly higher than that of the system, and the working of the system should not be affected by the discharge; the electrical energy of a static disturbance should be dissipated as rapidly as possible, and these static disturbances prevented from developing high potentials in the electrical machinery. While it is desirable to dissipate static disturbances rapidly, a too rapid discharge might set up secondary disturbances nearly, if not quite, as difficult to handle as the primary discharge; a point which is brought out in the British report. Hence the use of a high resistance connected in the arrester circuit, which tends to prevent oscillations. In lightning protection to-day it is the unexpected which bothers us, as well as the controlling of enormous energies suddenly appearing where they should not be.

National Electric Light Association.

Business Session Held at Denver, Col., June 6, 7, 8.

Reported by Telegraph for the Electrical Review.

DENVER, COL., JUNE 6—As early as Saturday the conventionists of the National Electric Light Association began to arrive in Denver, and by the opening of the meeting to-day the hotels, clubs and private houses all over the town were well filled. The first episode was the informal reception held in the drawing room of the Brown Palace Hotel. During the day the ladies were entertained by a coaching trip and luncheon at the Overland Country Club, and in the evening the entire seating capacity of the Elitch vaudeville theatre was taxed.

President Davis called the first meeting to order at the Brown Palace Hotel, at 10.30 A. M. The Hon. Robert W. Speer, mayor, was introduced and delivered a felicitous address of welcome. President Davis then delivered his address as follows:

For the first time in the history of the National Electric Light Association, its annual convention will be held west of the Missouri river, and no more typical city of the West could have been selected than the progressive municipality of Denver, and no more beautiful spot than Colorado Springs.

The choice of our place of meeting was a tribute to the development of the central station industry throughout the West and was intended to bring our western members in closer touch with the work and object of the association and to secure closer personal relations among our members from all sections of the country. The present convention may therefore be termed as somewhat missionary in its object.

The membership of the association generally grows proportionately smaller as we go westward, and it is expected that the Denver-Colorado Springs meeting will result in a large increase in our membership from the West. The state of Colorado is, however, an exception in that an unusually large proportion of the central stations located within its borders are now members of the association.

In this connection it will not be amiss to refer briefly to the work done by the association in recent years. The annual conventions offer the only general opportunity of personal exchange of thought and experience among a large number of central station managers as well as for the presentation of papers and discussions on matters of general interest. The field of the association is far broader than the benefit derived from such personal exchange of individual views and the reading of papers and discussions found therein.

The interest of the central station, considered as an industry, was what has lately received the best work and thought of your association; the vital questions being no longer preeminently those of management or type of plant, but rather those relating to stability and legitimate earning power of the industry.

The one and great menace to the industry is unwise, burdensome and restrictive legislation by the municipality and the state.

The right to tax is the power to destroy. The power to regulate contains the germ of the danger of confiscation, in whole or in part. The regulation of the industry by a commission that has such powers as are vested in the gas and the electric commission of the state of Massachusetts may be proper and satisfactory as safeguarding both the rights of the public and of the investor. But regulation by a commission brought into being by a manufactured public sentiment and having its inception in politics, and not primarily or honestly intended to remedy any admitted public oppression, or to properly regulate the use of the public franchises, can not be fair either to the public or to the investor, and must result in gross injustice to the industry.

The association should not be passive while laws placing the industry under the regulation of the commissions are passed by the several states without making proper suggestions, whereby which laws would be made reasonable and uniform in their provisions. Nor should it permit, without protest, the passage of any laws admittedly unduly restrictive and burdensome. The object should be to have the general laws of the several states relating to the industry conform to some standard, fair both to the public and to the industry.

For one state to grant only very limited term franchises under burdensome restrictions, and for another, and possibly an adjoining state, to grant perpetual franchises without restrictions; for one state to reserve the right to fix and change the rate of charge for service rendered, and for another state to empower any municipality to make any rate it may see fit, and to charge the same when and as it pleases, can not but injuriously affect the stability of the industry from the standpoint of the investing public.

I would, therefore, recommend the appointment of a standing commission on legislation to aid in protecting the interest of our members should occasion arise. The formation of state or sectional associations, whose object shall be to call the attention of interests affected by proposed legislation, and to secure concert of action for mutual protection, should be encouraged, which associations could very advantageously act in conjunction with your association committee on legislation. The good work in this direction already done by existing state or sectional associations has been very much appreciated by the interests benefited. It was my intention to suggest a codification of the laws of the several states relating to the central station industry for the benefit of our members and others interested, but the work has been done in a manner, and is now in book form. Another important question is that of municipal ownership, which, while as yet limited generally to the construction and operation by municipalities of plants for public lighting, is more than likely to result in the general interest to engage in private or commercial lighting, in aid of the public lighting. By way of self-protection the central station should more than live up to the obligation of its franchises, should furnish public light at reasonable prices; and serve the public so well that any agitation started for political or personal ends will not receive the support of a justly indignant public. As the basis of the argument for municipal ownership, that of a reduction in the cost of public lighting to the taxpayer, we should be prepared to answer this claim—as can be done—by the concrete results of the operations of existing municipally overrated plants. It is to be regretted that the League of American Municipalities has not accepted the proposition repeatedly made by the National Electric Light Association to join in a thorough and impartial investigation of the results.

Investigation of the results of the operations of existing electric lighting municipal plants in this country we know, but the public generally do not, shows such results do not justify or support even a part of the claims made by the advocates of municipal ownership. The amendments to the by-laws adopted at the last convention in relation to various classes of members have resulted in a satisfactory addition to our membership. Members of class B are officers or employés of member companies and are now 117 in number; members of class C are instructors and teachers of engineering and related sciences and now number thirty-nine; and associate members, class E, are officers or employés of associate member companies and now number sixty-eight. The total membership is now 824, as compared with 583 one year ago.

The Association of Licensed Manufacturers of Incandescent Lamps has appropriated the sum of $10,000 for the pur-

pose of effectively co-operating with the central lighting stations of the country for the increased use and, in consequence, sale of incandescent lamps. The plan contemplates its expenditure in two ways: first, to be helpful in stimulating central stations along advertising and new business lines; second, to assume the cost of preparation of an effectual and comprehensive plan of advertising and soliciting which, in consequence, could be furnished by some central bureau or advertising agency at a very low cost. As the plans suggested would be of value to the central station industry, I would recommend that a committee be appointed to work in conjunction with the Association of Licensed Manufacturers of Incandescent Lamps.

Our late president made some very pertinent suggestions as to the labors and difficulties attending the discharge of the duties of the president of your association, and of the value and necessity of having meetings of the executive committee during the interim between conventions, to secure a continuity of the established policy of the association, and to keep in close touch with the needs of our members in all sections of the country. The suggestions made I endorse. The individual policy and efforts of succeeding presidents, no matter how able they may be, can no longer do full justice to the interest of our members, widely scattered as they are. The executive committee must be the connecting link between the work of succeeding presidents. Its members should be selected, so far as possible, to represent geographically the several sections of our country and should meet often enough to place the president in touch with the needs of their localities. Steps should be taken to provide a place and facilities for a library to contain papers, periodicals and publications, issued from time to time, relating to all subjects of interest to the central station industry. The original data collected by several committees and reporters appointed from time to time should be filed in the office of the association, together with all the correspondence on the part of the executive officers of the association and others, relative to the important questions that fall to their lot to deal with. Each president, in turn, is handicapped by finding substantially no record in detail of the work of any of his predecessors, and is therefore at a great disadvantage in attempting to deal with any important question that may overlap the term of more than one president, or may have some relation to events of the past. A committee should be appointed to consider and report on the proper method of grounding secondaries of alternating-current distributing systems, so as to minimize the risk and danger to property and life. The suggestion made by the committee for the investigation of steam turbines, that its work be continued, is endorsed. While not strictly within the objects of the association, it would be well for our members to consider the advisability of consolidating the street railways, gas and electrical companies in any given locality, as not only would the public be better served but the total investment would be more stable and the results unusually satisfactory. During the holding of the Louisiana Purchase Exposition, in 1904, your association, through the kindness of the Association of Edison Illuminating Companies, was granted the use of part of its space at the exposition for the association of our members, and I desire to take this occasion to thank our sister association for the courtesies extended.

At the meeting of the International Electrical Congress, held in September, 1904, at the exposition, your association was ably represented by the gentlemen selected at its Boston meeting. I desire, therefore, to thank Mr. George Ross Green, Professor Frederick A. C. Perrine, and Mr. George N. Eastman for their very able papers and the manner in which they sustained and added to the reputation of the association. But few of us appreciate the tremendous power of the association, the great possibility for good or evil that rests in the direction of its policy and the importance of the interests involved. Our relations to the great public, our customers; to the legislative power to which we are all subjects; to the municipality under whose franchises we operate; to the great manufacturers of apparatus and supplies; to the insurance interest with whom we must always maintain the most intimate relations; and last, but not least, to our stockholders and all others pecuniarily interested in the properties we manage, are the great and vital questions that are now uppermost. It will be for future administrations to deal wisely and conservatively with them.

The president's address was referred to a committee composed of Ferguson, Frueauff, Stetson, Scovil and Carnes. T. C. Martin read the report of the progress committee.

Dr. Louis Bell's report on "The Tantalum Lamp" was read. This was discussed by J. R. Cravath, Arthur Williams, John F. Gilchrist, D. C. Farrand, A. C. Dunham and W. H. Gardiner, Jr., Boston.

All speakers favored this lamp. Mr. Williams said that as an illuminant it is certainly very interesting and promises well for the future, but as there probably have not been more than 100 of these lamps in this country, and they have not been here long enough to be subjected to any kind of commercial test, he did not think it would be practicable to discuss the lamp in any commercial sense. He did not think because of the high price at which the lamp is obtainable that it will be immediately a competitor with the ordinary incandescent lamp. Mr. Gilchrist said the bringing out of this lamp raises the question of selling electricity for illuminating purposes, particularly incandescent lighting, on the lamp-hour basis instead of the kilowatt-hour basis.

Mr. Farrand said they have had two tantalum lamps. The first showed an efficiency of 1.99 watts per candle, which is better than that mentioned by Dr. Bell. That lamp, however, lasted only some twenty odd hours. The second lamp is still burning and shows an efficiency of 1.68 watts per candle. He did not know how long it would continue to burn. The commercial efficiency is a matter which will have to be determined. The theoretical efficiency to very little.

W. H. Gardiner said the unit of illumination in the tantalum lamp shows up approximately on the same basis as its competitor and after comparisons with other lamps thought we should welcome the tantalum lamp.

The paper on "The Paramount Importance of Standard in Preference to Special Machinery," by David Hall, was read.

In discussion, E. F. McCabe said it would be a wise idea for the manufacturers to get together and standardize the machine. What we want is to have machines that are not special except in minor details. H. T. Hartman endorsed Mr. McCabe's point of view.

The paper on "Insulation Testing—Methods and Apparatus," by C. E. Skinner, was presented, but there was no discussion, and the meeting adjourned.

The afternoon session was called to order at 2.30.

Paul MacGahan's paper on "Automatic Synchronizing of Generators and Rotaries" was read. No discussion. Louis E. Bogen's paper was presented, entitled "Notes on Rotary Converters and Motor-Generators for Lighting and Power Systems."

Clarence Renshaw, of Pittsburg, said he differed with Mr. Bogen in regard to sixty-cycle rotaries for voltages of 240 and 500. He also called attention to Mr. Bogen's failure to indicate the ability of a synchronizing machine to affect the voltage of the system by means of changes of load on the synchronized machine. Alex Dow said, that in the question of motor-generators as against rotaries, the distinction is not always made as it should be between the conditions of railway service and the conditions of lighting service. The points of this paper were then discussed in its various technical phases. Mr. Gille concluded the discussion by calling attention to the advantages and the disadvantages of both rotaries and motor-generators as to reliability of service in the case of lightning troubles on transmission lines.

Mr. Williams resumed the discussion of the progress committee's report by calling attention to the use at Detroit of exhaust steam for the purpose of evaporating brine and thereby deriving salt. He also referred to the calculations made by Mr. Pearce, a prominent English engineer, on the relative costs of the different artificial illuminants in which the conclusion is reached that the cost per mean candlepower per hour for the arc lamp is 0.66, whereas for the intensified gas lamp the cost rises to 0.79. The references to the use for special purposes of the mercury vapor lamp were commended as well as the use of the Nernst lamp. He called attention to the interesting information that the objections to the use of the osmium lamp at 110 volts have not been overcome; an enquiry was also made, but not answered as to whether osmium

lamps were obtainable. The data submitted by J. C. Chamberlain on electric refrigeration were commended as being worthy of special study.

W. C. L. Eglin, of Philadelphia, asked a question relative to the Cooper Hewitt lamp as to how the candle-power is determined, and what is being done toward making a more direct comparison between this and the arc lamp?

Alex Dow, referring to the report stated that the salt works were not growing. It has been money in one's pockets to stay out of the salt business. The reasons are not electrical nor mechanical, but purely financial. In the present peculiar conditions of the salt market they have found good financial reasons for stopping the drilling of salt wells, pending a change in the salt business. There are, however, a number of electrochemical processes, particularly electrometallurgical, which are not necessarily continuous, but which can be run profitably at hours which are not peak-load hours. The discussion of this report was concluded by an extended analysis by Alex Dow on special conditions at the Detroit station.

W. P. Hancock's paper on "The Organization of Working Forces in Large Power-Houses" was presented.

W. B. Jackson said that not only is there a value in keeping the plant neat and clean, but also the moral of the employés would be so much better and they will be so much cleaner on account of the plant being clean in every detail. Mr. Hartman speaking of labor troubles, said his experience is that where men are well paid and well treated the trouble generally comes from the outside. Mr. Hancock said he has not a union man on his payroll. His men are far above the average of men who are in the unions in the same class of service. Mr. Durham said in the last three years they had given their men a six per cent dividend, and there has never been an opening for a union man since.

W. C. L. Eglin presented the report on "Turbines," followed by A. H. Kreusi on "Operating Factors of the Curtis Steam Turbine," on which discussion was postponed until Wednesday morning.

WEDNESDAY SESSION.

DENVER, COL., JUNE 7—President Davis called the meeting to order at 10 A. M. The paper by Clarence Renshaw, on "Series Alternating-Current Motors for Industrial Work," was read. This paper and the one which followed it, being allied, a joint discussion was held on both.

The paper by S. Percy Cole, on "New Type of Single-Phase, Alternating-Current Motor for Elevator Work," was read. The discussion was participated in by Messrs. Renshaw and Eglin. Mr. Cole, in answer to questions, stated that it was the intention of his company to develop this type of motor for hoists and traveling crane service. It is intended to cooperate with manufacturers of traveling cranes and elevators.

Replying to the question as to what cities were changing whole sections from direct to alternating current, he could not name the cities, but it is a fact that in St. Louis there is a section in which only alternating current is used.

Mr. Renshaw said that it seemed to him as if this motor corresponds to a direct-current motor, and is but little better than a shunt motor. Of course, in elevator service a compound motor is desired, but for cranes and hoists a series motor is wanted.

Mr. Cole raised a question as to whether a sixty-cycle motor could be wound for the same voltage as a twenty-five-cycle motor, or for any voltage up to 600. Mr. Renshaw replied that the question is largely one of the size of the commutator bars required. The higher frequency requires a greater number of bars, making a mechanical difficulty in constructing the smaller sizes.

The discussion of the turbine report presented yesterday was taken up. This was participated in by E. F. McCabe, A. H. Kreusi and W. C. L. Eglin.

Replying to a question by Mr. McCabe, as to whether the turbines were being operated by exhaust steam, Mr. Kreusi replied that some were nearly ready. Mr. Eglin said that two sets had been ordered for the Philadelphia Rapid Transit Company.

In the absence of John A. Britton, his paper, "Long-Distance, High-Tension Transmission in California," was read by title, and will be published in the proceedings.

The report by Alex Dow on "Present Methods of Protection from Lightning and Other Static Disturbances" was presented. Mr. Dow recommended that the association appoint a reporter to handle this subject.

C. R. Maunsell asked if any case were known of the puncturing of the lead lining of storage batteries by lightning on railway systems. Mr. Dow replied that, to his knowledge, no case had been reported, but flashing across the battery terminals to ground occurs.

R. F. Hayward described conditions existing on Utah transmission lines up to 40,000 volts. Based on General Electric and Westinghouse data and his own observations, he believed that lightning protection should be special over all lines in the form of lightning conductors. His practice is to ground one or two circuits at each end of the line before thunderstorms.

E. P. Dillon discussed conditions to be met in this connection in Colorado. Further discussion was participated in by Messrs. Hartman, Jackson and Dow.

E. R. Roberts's paper on "The Nernst Lamp, Its Present Performance and Commercial Status," was presented.

M. J. Hazard asked the present price of Nernst lamps for direct currents.

In reply to a question, Mr. Roberts said that the tests on direct-current lamps recently showed favorable results. The company will distribute lamps for commercial tests by various central stations, and the results of these tests will determine whether these lamps will soon be marketed.

Arthur Williams said that he found the Nernst lamp did not materially interfere with the incandescent lamp or the arc lamp, but fills a gap. The Nernst lamp is of high quality, and gives satisfaction where used. The best field is for the three and six-glower lamps. The life is fairly satisfactory, and the lamp is renewed at low cost. The income is about twice the income of a sixteen-candle-power incandescent. The lamp has gained the patronage which would have otherwise gone to the intensified gas burner.

Mr. Durham said that the Nernst lamp had performed an important service in an installation where thirty five-glower lamps were used. He also gave further interesting data relative to the life and economy of the lamp. The suggestion that the cost of the Nernst lamp be reduced was applauded. The meeting then adjourned until 8 P. M.

This evening the ladies were entertained at a performance in the theatre. The men were entertained at a well-attended smoker.

Evening meeting was called to order at eight o'clock. E. P. Dillon's paper, "Some Investigations of Induction Losses," Wallace S. Clark's paper, "The Choice of an Insulated Cable," and P. D. Wagoner's paper, "Mercury Arc Rectifiers," were read. Mr. Wagoner gave a practical demonstration of this apparatus.

Mr. Scovil presented an amendment to the by-laws, making the retiring presidents members of the executive committee for one year after the expiration of their term. This was referred to a committee composed of Messrs. Doherty, Hartman and Brine.

The reports by Percy Ingalls on "Advertising Methods," on "Sign and Decorative Lighting," by La Rue Vredenburgh, on "Free Signs and Flat Rates," by G. W. Lee, were presented, the discussion being opened by John Craig Hammond, advertising manager, Denver Gas and Electric Company. Many interesting samples of advertising literature were shown, the discussion being taken up by Messrs. Ingalls, Lee, Hewitt, Rawlins, McCabe and Williams.

THURSDAY SESSION.

DENVER, COL., JUNE 8—The meeting was called to order at 10 A. M. J. R. Crouse read portions of his paper concerning better cooperation between manufacturers and middlemen. He announced a contribution by the manufacturers of $10,000 to cooperate with central stations for greater use of incandescent lamps.

President Davis thought that later on a committee might be formed to carry on this work as outlined by Mr. Crouse. The discussion on advertising, particularly as relates to small cities, was resumed, Messrs. Watson, Emerick, Sells, Wilcox, Russell, and Gardiner, taking part. This subject was given lengthy analysis, that it might be considered a most important feature of the proceedings.

The report on "Progress in Electric

Heating," was presented by James I. Ayer, and discussed by A. L. Selig, California; F. H. Corst, Wisconsin; Julian B. Downey, Wyoming; Arthur Williams, E. F. McCabe, H. W. Hillman and W. H. Blood, Jr.

The Thursday afternoon session was opened by the report by W. H. Blood, Jr., on "District Heating," which was discussed by C. R. Maunsell, H. J. Gille, J. E. Pyle.

The nominating committee, L. A. Ferguson, Paul Doty, Paul Spencer, N. F. Brady, and Samuel Scovil, was appointed.

E. W. Lloyd's report on "Purchased Electric Power in Factories," was read and discussed by E. H. Davis and H. J. Gille. The "Wrinkles" and "Question Box" were presented but not discussed.

ELECTION OF OFFICERS.

The nominating committee made presentations as follows, which were confirmed:

President, W. H. Blood, Jr., Seattle, Wash.

First vice-president, Arthur Williams, New York.

Second vice-president, Dudley C. Farrand, New York.

Executive committee, for three years, C. L. Edgar, John Martinson, Frank Frueauff, W. C. L. Eglin.

It was recommended that the executive committee appoint the secretary and treasurer.

Invitations for the next meeting were received from Brooklyn and Buffalo. Brooklyn (Manhattan Beach) will probably be selected.

The executive session listened to reports on "Relation with Kindred Organizations," James I. Ayer, chairman; "Rates and Costs," Charles L. Edgar, chairman; "Municipal Ownership," Arthur Williams; and "Standard Rules," Charles L. Edgar, chairman.

The reports of the secretary and treasurer were read, and after the report of the executive committee the convention, at seven o'clock, adjourned. S. H. G.

CONVENTION NOTES.

Manufacturers and Representatives Present—Souvenirs Distributed.

DENVER, COL., JUNE 8—The fine Allis-Chalmers installation at the Denver Gas and Electric plant was inspected by many delegates. This plant was more or less the centre of interest. It contains, among other apparatus, two 1,500-kilowatt, sixty-cycle Bullock direct-connected alternators; four 600-kilowatt, three-phase Bullock belted alternators, and two 400-kilowatt, direct-current belted generators. This is by far the largest generating plant in the West. The Allis-Chalmers representatives at the convention were M. C. Miller, of the executive department, Milwaukee; O. A. Stranahan, power department; C. A. Tupper, department of publicity; George H. Berg, Boston manager; George B. Foster, Chicago manager; Robert J. Glendinning, assistant district manager; R. B. McConney, district manager, Denver; H. L. Woolfenden, electrical department, Denver; J. R. Jeffrey, assistant secretary.

The Bullock Electric Manufacturing Company, the electrical manufacturing department of the Allis-Chalmers Company, was represented by David Hall, assistant chief electrical engineer; Louis E. Bogen, engineer, Bullock company, Cincinnati.

The General Electric Company was represented by General Ervin Hale, manager of the Denver office; G. A. Wooley, superintendent of the Denver office; E. E. Gilbert, lighting department, Schenectady; P. D. Wagoner, sales department, Schenectady; F. G. Vaughan, sales department, Schenectady; W. S. Clark, wire and cable department, Schenectady; A. H. Kreusi, engineering department, Schenectady; H. W. Hillman, sales department, Schenectady; Frank W. Wilcox, assistant manager, incandescent lamp department; F. H. Gale, manager advertising department; A. D. Babson, sales manager, New York; H. C. Hauck, sales manager, Cincinnati; H. J. Dudley, sales department, Philadelphia; J. H. Livesy, sales department, Detroit; J. Scribner, lighting department, Chicago; W. H. Smith, sales department, Minneapolis; C. B. Burleigh, engineering department, Boston; C. B. Mahoffey, engineer, Denver office; A. D. Grouch, Salt Lake City; Otis Turner, Dallas, and H. C. Glaze.

The National Electric Company—Hendrie & Bolthoff Manufacturing and Supply Company, Denver agents; C. O. Poole, sales department, and C. G. Burton, general sales agent.

Fort Wayne Electric Works—J. J. Wood, electric designer and general superintendent; F. S. Hunting, sales manager; A. A. Serva, assistant sales manager; A. L. Searles, manager, Grand Rapids, Mich., office; W. S. Goll, manager, Chicago office.

Baker & Company, Inc., Newark, N. J.—C. O. Baker.

Stanley Instrument Company—F. J. A. Alderson, sales department; A. S. Ochs, sales department; C. R. Spence, sales department.

Pass & Seymour, Syracuse—manager John W. Brooks.

The Switchboard Equipment Company—A. C. Lavidge, sales manager, Pittsburg.

New York Insulated Wire Company—B. K. Sweeney, Denver.

Crocker-Wheeler Company—Lewis W. Ward, Denver; R. E. Miller, W. F. Sullivan and Julian Roe, manager, Chicago office.

Chicago Edison Company—Chicago, Homer Niesz, assistant to second vice-president; John F. Gilchrist, contract agent.

Atlantic Insulated Wire and Cable Company—George F. Porter, New York.

Electric Storage Battery Company—G. H. Atkins, Chicago, manager; Theodore B. Entz, contract agent.

H. W. Johns-Manville Company—James W. Perry, manager; J. W. Hardy, Milwaukee.

Western Electric Company—W. L. Tucker; E. W. Rockfellow and W. F. Hessell.

L. Pearson Company, Boston—W. G. Olson.

The Arnold Company, Chicago—W. L. Arnold, vice-president.

National Carbon Company—N. C. Cotabish, sales manager; J. L. Crider, secretary; J. F. Kerlin, assistant sales manager.

American Circular Loom Company, Chelsea, Mass.—Thomas E. Grier, western manager.

Simplex Electric Heating Company, Boston—James I. Ayer, C. W. Richards.

New York & Ohio Company, Warren, Ohio—W. D. Packard.

Western Chemical Manufacturing Compan, Denver—L. B. Skinner.

Ray D. Lillibridge, New York.

National Battery Company, Buffalo—J. W. Gillette, general sales manager.

Farr Electric Company, Chicago—James M. Gilchrist, manager.

Electric Appliance Company, Chicago—W. W. Low, president.

National Electric Lamp Company, Cleveland—J. Robert Crouse.

Okonite Company, New York—George T. Manson, general superintendent.

Reynolds Electric Flasher Manufacturing Company, Chicago—I. A. Bennett.

Bryan-Marsh Company, Chicago—E. S. Haughton, S. E. Doon.

Osburn Flexible Conduit Company, New York—T. A. Bennett, Chicago, manager.

Buckeye Electric Company, Cleveland—L. P. Sawyer, manager.

Speer Carbon Company, St. Mary's Pa.—J. S. Speer, general manager.

Nernst Lamp Company, Pittsburg—Max Harris, Arthur F. Solomon, D. Matthews, E. R. Roberts.

The exhibit of the Westinghouse Companies adjoined the convention hall. This was very attractive on account of the elaborate decorations. The Westinghouse Electric and Manufacturing Company was one of few large manufacturers to have an exhibit of apparatus, including arc lamps, lightning arresters, meters, transformers, circuit-breakers, small motors, etc. The headquarters of the Westinghouse Companies included a room where refreshments were served. The great Westinghouse banner was suspended from

the centre of the dome one hundred feet above make a striking effect.

The Nernst Lamp Company's exhibit of line of lamps was in the Hotel Savoy. E. R. Roberts, of Pittsburg, was in charge.

The Westinghouse Companies delegation consists of the following: from Westinghouse Electric and Manufacturing Company, C. S. Cook, manager of the railway and lighting department; C. B. Humphrey, manager, detail and supply department; G. B. Griffin, assistant manager of the same department; P. Davis, assistant chief engineer; W. C. Webster, assistant to the second vice-president; Mr. Whipple, general lamp agent; P. N. Jones, manager Pittsburg office; L. M. Cargo, manager, Denver district office; C. E. Skinner, Paul McGahan, K. C. Randall and Clarence Renshaw, engineers; Mr. Chase of the New York sales office; W. R. Pickard of the Chicago district office; H. S. Sand, E. C. Means and B. S. Manuel of the Denver district office; from the Nernst company, Max Harris, sales manager, S. Solomon and R. D. Matthews, Pittsburg, managers, E. R. Roberts, Pittsburg; Westinghouse Machine Company, C. C. Shappel, manager, Denver. The arrangements were in charge of J. C. McQuiston, superintendent publishing department, and L. M. Cargo, manager, Denver office.

Dearborn Drug and Chemical Works, Chicago—Fred A. Earls, Robert W. Francis, George R. Carr.

The Phelps Company, Detroit—W. J. Phelps, president, and J. Wiley Phelps, secretary.

Chase-Shawmut Company, Newburyport, Mass.—George A. Grey.

India-Rubber and Gutta-Percha Insulating Company, New York—James B. Olson, manager.

American District Steam Company, Lockport, N. Y.—Charles R. Bishop, secretary and general manager.

The Standard Paint Company, New York—H. C. Eddy, western manager; B. C. Beckman, and Charles Carnshaw, New England manager.

Sangamo Electric Company, Springfield, Ill.—R. C. Lanphier, superintendent.

Moloney Electric Company, St. Louis, Mo.—T. O. Moloney, president.

Phœnix Glass Company, New York—A. H. Patterson and E. H. Fox.

Philadelphia Electric and Manufacturing Company, Philadelphia—C. L. Bundy, manager.

Duncan Electric Manufacturing Company, Lafayette, Ind.—William H. Sinks.

American Electrical Works, Phillipsdale, R. I.—Francis E. Donohue, western agent.

Standard Underground Cable Company—J. R. Wiley, Chicago manager; E. J. Pietzcker, southwestern manager.

Wagner Electric Manufacturing Company, St. Louis—G. Percy Cole, electrical engineer; V. W. Bergenthall, assistant sales manager.

J. S. Codman Company, Boston—Charles Codman, president.

Stanley-G. I. Electric Manufacturing Company, Pittsfield, Mass.—Martin J. Insull, third vice-president.

Benjamin Electric Manufacturing Company, Chicago—R. B. Benjamin, vice-president.

American Electrical Supply Company, Chicago—C. Edward Browne, president.

Sawyer-Man Electric Company, New York—Walter Cary, sales manager.

Jeffrey Manufacturing Company, Columbus, Ohio—Frank R. Field.

American Steel and Wire Company—H. J. Woelke, Denver, manager.

Triumph Electric Company, Cincinnati—George A. Stiles.

Pittsburg Reduction Company—John H. Finney, manager.

American Conduit Company, Chicago—A. L. Wetherbury, general manager.

Central Electric Company—J. A. Savage.

Columbia Incandescent Lamp Company, St. Louis, Mo.—J. S. Lehman, manager.

A number of those usually active, socially and otherwise, were regrettably absent. Among these, Charles Blizard, John Dale, A. C. Garrison, H. H. Gearey, C. E. Corregan, Dan Hemingway, C. P. Hill, B. C. Kenyon, H. B. Kirkland were missed. Although Mr. Kirkland was absent, he had provided through his associate, Mr. Grier, two automobiles, for the use of the tired ones. This courtesy was greatly appreciated.

Many unique souvenirs were distributed, among which might be mentiond the following:

National Carbon Company, electric flash lamp. Allis-Chalmers Company, National Electric Company, Central Electric Company, watch fob. Osburn Flexible Conduit Company and Philadelphia Electric Manufacturing Company, scarf pin. Dearborn Drug and Chemical Company, perfume. Phelps Company, "Hylo" cigarettes. India-Rubber and Gutta-Percha Insulating Company, cigar holder.

S. H. G.

RAILWAY MEN'S CONVENTION.

AMERICAN RAILWAY MASTER MECHANICS JUNE 14 TO 16; MASTER CAR BUILDERS, JUNE 19 TO 21, MANHATTAN BEACH, LONG ISLAND, N. Y.

THE thirty-eighth annual convention of the Railway Master Mechanics' Association will be held at Manhattan Beach, L. I., N. Y., on June 14, 15 and 16, 1905. The thirty-ninth annual convention of the Master Car Builders' Association will also be held at Manhattan Beach on June 19, 20 and 21, 1905. The headquarters of both associations will be at the Oriental Hotel. During the period the two conventions are in session, the hotel will be reserved for the exclusive use of the members and their guests, including the Railway Supply Men's Association.

The following programme has been arranged for the American Railway Master Mechanics' Association:

The opening session will be held on Wednesday, June 14, from 9.30 A. M. to 1.30 P. M. After routine business has been transacted there will be a discussion, from 11 to 11.30 A. M., on the report of the committee on "Proper Loading of Locomotives." From 11.30 A. M. to 12 M. there will be discussion of the report on "Locomotive Tests of the Pennsylvania Railroad Company at St. Louis Exhibition." Lawford H. Fry, of the Baldwin Locomotive Works, will open the discussion on "The Best Known Dimensions for Water Space Around the Fire Box to Produce a Minimum Consumption of Fuel; and Replacement of Fire-Box Sheets, and Reasons for the Same." William Garstang will next open the discussion on "Locomotive Stokers." Following this there will be discussion of a paper by H. H. Vaughan, on "The Value of Superheated Steam for Locomotive Works."

The second session will be held Thursday, June 15, from 9.30 A. M. to 1.30 P. M. There will be discussion of reports on "Locomotive Driving and Truck Axles and Locomotive Forgings," "Shrinkage Allowance for Tires," and "Motive-Power Terminals." Following this there will be a discussion of a paper presented by George M. Basford, on "The Technical Education of Railroad Employés—the Men of the Future." There will also be topical discussions on "High-Speed Steel" and on "Staybolts," followed by a discussion of the report on "Flexible Staybolts."

The closing session will be held Friday, June 16. The reports of the committees on "Water Softening for Locomotive Use," "Service of Locomotives," and "Shop Layouts" will be discussed from 9.30 A M. to 11.30 A. M. Following these discussions C. B. Young will present a paper on "(*a*) Proper Lubrication of Valves when Drifting; (*b*) Relative Set for Piston and Slide Valves." Following Mr. Young's paper, topical discussions will be held on "Relief and Bypass Valves for Locomotives," and "Are Engines with Self-Cleaning Front Ends Satisfactory?" Correspondence and resolutions will be taken up after the topical discussions, followed by the election of officers. After the election of officers, adjournment will be taken.

The present officers of the association are: president, Peter H. Peck, master mechanic, Chicago & Western Indiana Railroad, Chicago, Ill.; treasurer, Angus Sinclair, 136 Liberty street; secretary, Joseph W. Taylor, 390 Old Colony Building, Chicago.

The Colorado Springs Electric Company.

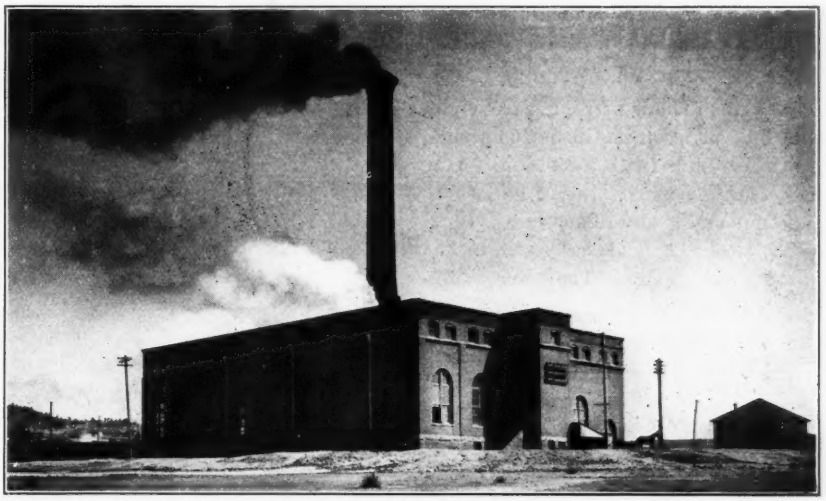
By E. P. Dillon.

THE history of the system now owned and controlled by the Colorado Springs Electric Company makes an interesting story and is characteristic of the substantial growth and development of the West.

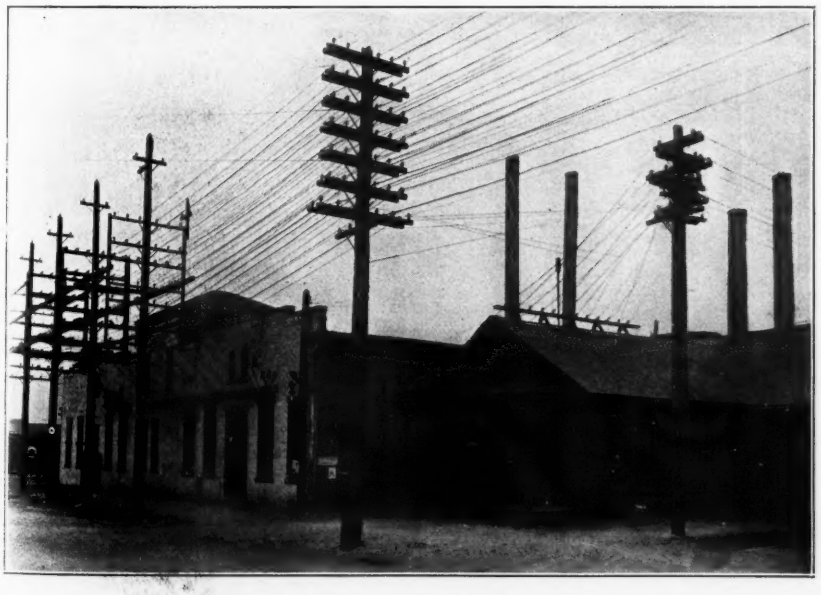
The first central station in Colorado Springs was installed in 1886, and consisted of a fifty-horse-power engine belted to a 600 sixteen-candle-power light Edison generator. This capacity was increased from time to time, being doubled in the second year. In 1899 the plant was moved to the site of the present Colorado Springs substation on Cucharras street.

An important historical note is that the Westinghouse company installed a 1,000-volt alternating-current generator at the new plant. This was the second alternating-current generator to be installed in the United States.

The Colorado Springs Electric Company was organized in 1900 and took over the property of the El Paso Electric Company, and began at once to construct the large steam-generating station at Austin Bluffs. This location was chosen because of the close proximity to extensive lignite coal banks, which are operated by a local coal company. The coal from these mines furnishes a very cheap fuel in the form of slack, or mine-run when the slack does not suffice. The mine is situated about 1,500 feet from the power-house, and the coal is conveyed to the boiler-room conveyer by a two-car gravity surface tram. From here the coal is taken in a conveyer and distributed to the bins in front of the boilers. A good supply of feed water is obtained from a large pipe-line running close to the plant and supplied from a reservoir in the mountains to the north. This feed water is a very fair quality for boiler purposes. A storage reservoir of 500,000 gallons capacity offers an adequate reserve for feed-water purposes, being located adjacent to the plant.



MAIN GENERATING PLANT, AT AUSTIN'S BLUFF, OF THE COLORADO SPRINGS ELECTRIC COMPANY.



SUBSTATION "A," COLORADO SPRINGS ELECTRIC COMPANY.

POWER-HOUSE.

The power-house is of red pressed brick and sandstone trimmings, adequately lighted by large windows. The roof is supported on steel trusses which extend the entire width of the building and are supported near the centre by a brick partition which divides the engine room from the boiler room. The floor of the engine room is supported on steel beams resting on cast-iron bearing-plates in a masonry wall. The engine room is served with a twenty-ton Maris Brothers' hand-power traveling crane which extends the entire width of the room, running the full length of the power-house on sixty-pound T-rails placed on heavy I-beams, which are in turn supported on brick pilasters built up from the building foundation.

The boiler room is sixty feet by 160 feet nine inches, its floor level being nine feet below the floor level of the engine room. The boiler equipment consists of five Aultman-Taylor boilers of the Cahall horizontal sectional water-tube type of 400 horse-power each, set in five batteries; two Babcock & Wilcox water-tube boilers of 500 horse-power each, set in two batteries, thus making a boiler capacity of 3,000 horse-power. The working steam pressure is 160 pounds. The stack, which furnishes natural draught for the boilers, is steel, self-supporting, being 101 feet six inches high above the capstone of the pedestal, and nine feet six inches inside diameter. The pedestal is built of brick and extends from the foundation to a height several feet above the roof of the building. The total height of stack and pedestal is 170 feet. The steam piping is designed on

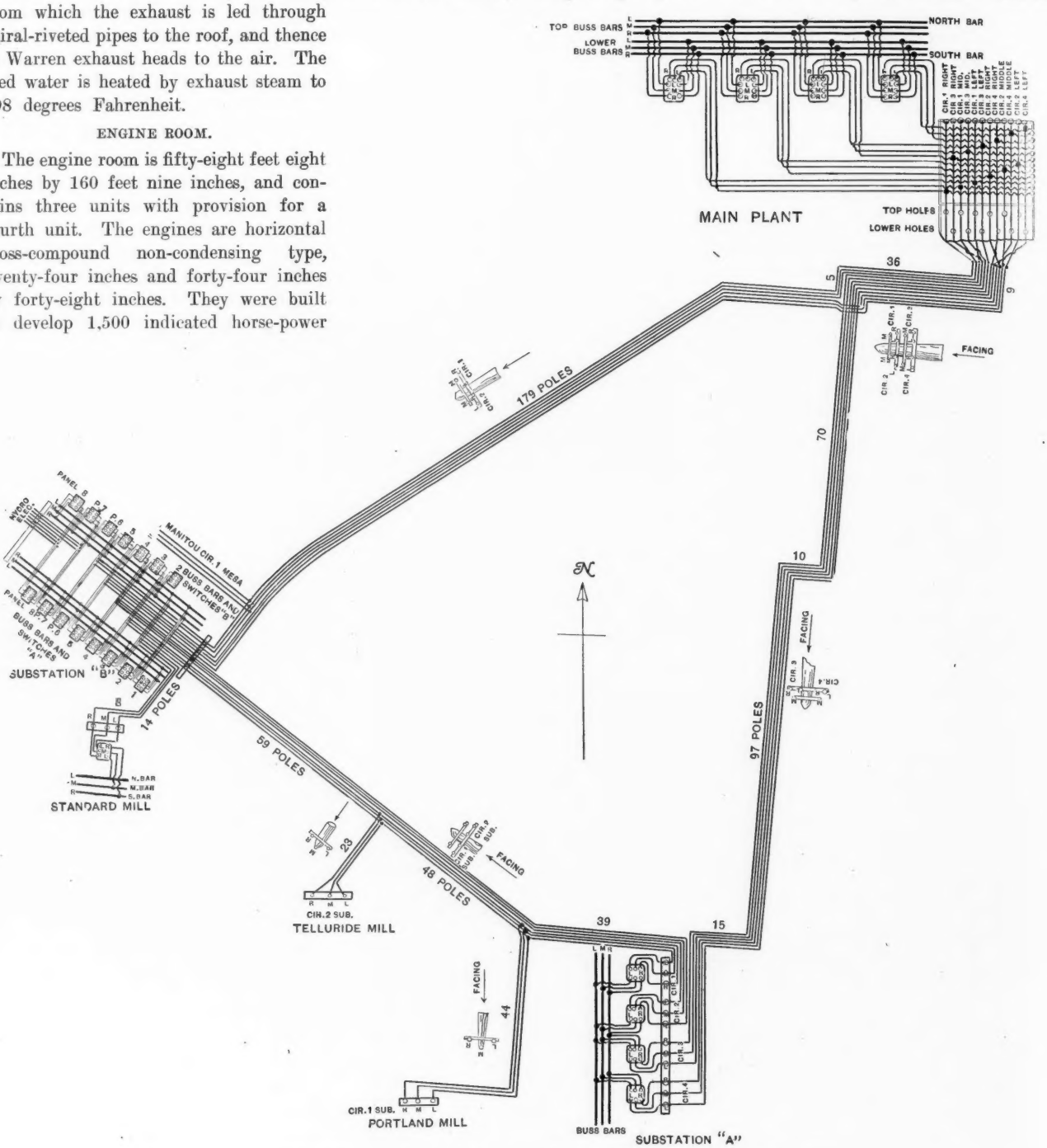
the feeder and main principle and embodies long sweeps between boilers and header and long easy bends to the engines. Between engines and header are separators which serve as steam reservoirs as well as separators. Each engine exhausts into a common cast-iron header, from which the exhaust is led through spiral-riveted pipes to the roof, and thence to Warren exhaust heads to the air. The feed water is heated by exhaust steam to 198 degrees Fahrenheit.

ENGINE ROOM.

The engine room is fifty-eight feet eight inches by 160 feet nine inches, and contains three units with provision for a fourth unit. The engines are horizontal cross-compound non-condensing type, twenty-four inches and forty-four inches by forty-eight inches. They were built to develop 1,500 indicated horse-power when operating at 150 pounds steam pressure and running at ninety revolutions per minute. The engines were built by the International Power Company. Each engine is direct-connected to a General Electric 750-kilowatt, three-phase, 6,600-volt, sixty-cycle revolving field generator. Each unit is equipped with a 70,000-pound flywheel twenty feet in diameter. Experience has shown that these units operate very smoothly in parallel. The two main exciters are General Electric make, having a capacity of fifty kilowatts at 125 volts. They are direct-connected to Ames Iron Works high-speed engine.

The automatic potential regulator installed in this plant gives excellent regulation on the system, notwithstanding that the load is composed chiefly of induction and synchronous motors. To facilitate the operation of the regulator a small motor-generator set was installed to separately excite the shunt-fields of the main exciters. The regulator works on the shunt of the separate exciter. This removes the regulator several steps from the main generator, but practice has demonstrated that the scheme is satisfactory.

The switchboard is of marble and carries sufficient instruments to keep an accurate record of the performance of the



PLAN OF THE DISTRIBUTION SYSTEM OF THE COLORADO SPRINGS ELECTRIC COMPANY.

plant. Each unit is given a separate panel, as well as each outgoing circuit. The switches are oil-type, hand-operated, nearly all being three-pole double-throw. The switches, rheostats, instrument transformers, etc., are placed beneath the floor and are hand-operated from switch-point panels. From the switchboard the circuits pass through the lightning arrester room, thence out of the building to the line. The voltage of the line is 6,600 volts, or the voltage of the generators. Each circuit is equipped at the main plant with non-arcing lightning arresters, each leg carrying four 2,000-volt double-pole arresters, placed in a vertical row, and so connected as to give a series multiple path to the ground. This arrangement has proven very satisfactory on this system, and has given much better service than the former method of placing each arrester in a horizontal position and compelling the discharge to take an irregular path to the ground.

THE TRANSMISSION SYSTEM.

The transmission is arranged in the form of a triangle with the main plant, substation "A," Colorado Springs and substation "B," Colorado City, at the angles of the triangle. As will be seen from the map of the system, each pole line carries a double circuit, consisting of three No. 1 copper wires placed sixteen inches centres. The poles are mostly forty feet Oregon white cedar, set on an average 100 feet apart. An inspection of the diagram of the transmission system shows that duplicate service is assured at each of the substations.

SUBSTATION "A."

Substation "A" is located on West Cucharras street, Colorado Springs, and is the original plant of the El Paso Electric Company. This substation is the main distributing point for both commercial and street lighting in Colorado Springs and Colorado City. The voltage is stepped down from 6,600 to 2,300 volts, at which pressure the lighting service is distributed. This transformation is effected through four 375-kilowatt oil water-cooled transformers. The substation also has a twenty-four-inch by forty-inch simple non-condensing Frick-Corliss engine belted to line shaft, and one 100-horse-power Westinghouse engine direct-connected by means of clutches to the line shaft.

The boiler equipment at the substation consists of 1,500 horse-power in water-tube and tubular boilers, with all necessary feed pumps, water heaters, etc. High-pressure steam is maintained throughout the year for service to laundries, hotels, etc., for laundry and cooking purposes. Through the heating season the engine is operated and the exhaust steam is used in connection with the low-pressure heating system in Colorado Springs. The line shaft to which the engine is belted drives a 150-kilowatt bipolar and two seventy-five-kilowatt, multipolar 500-volt generators, and also a 300-kilowatt, three-phase, sixty-cycle, 2,300-volt generator. The 500-volt machines are used for supplying direct-current power service to elevators, motors, etc., within the business district of Colorado Springs. The three-phase

INTERIOR OF ENGINE ROOM, AUSTIN'S BLUFF PLANT, COLORADO SPRINGS ELECTRIC COMPANY.

generator is connected in the secondary side of the main transformers and operates either independently or in parallel with the main generating station when running as a generator through the heating season. When the engine is out of commission this alternator is used as a synchronous motor to drive the 500-volt generators above mentioned. The use of this synchronous motor is a considerable help to the system, as it is used partially as a rotary condenser to improve the power-factor of the system.

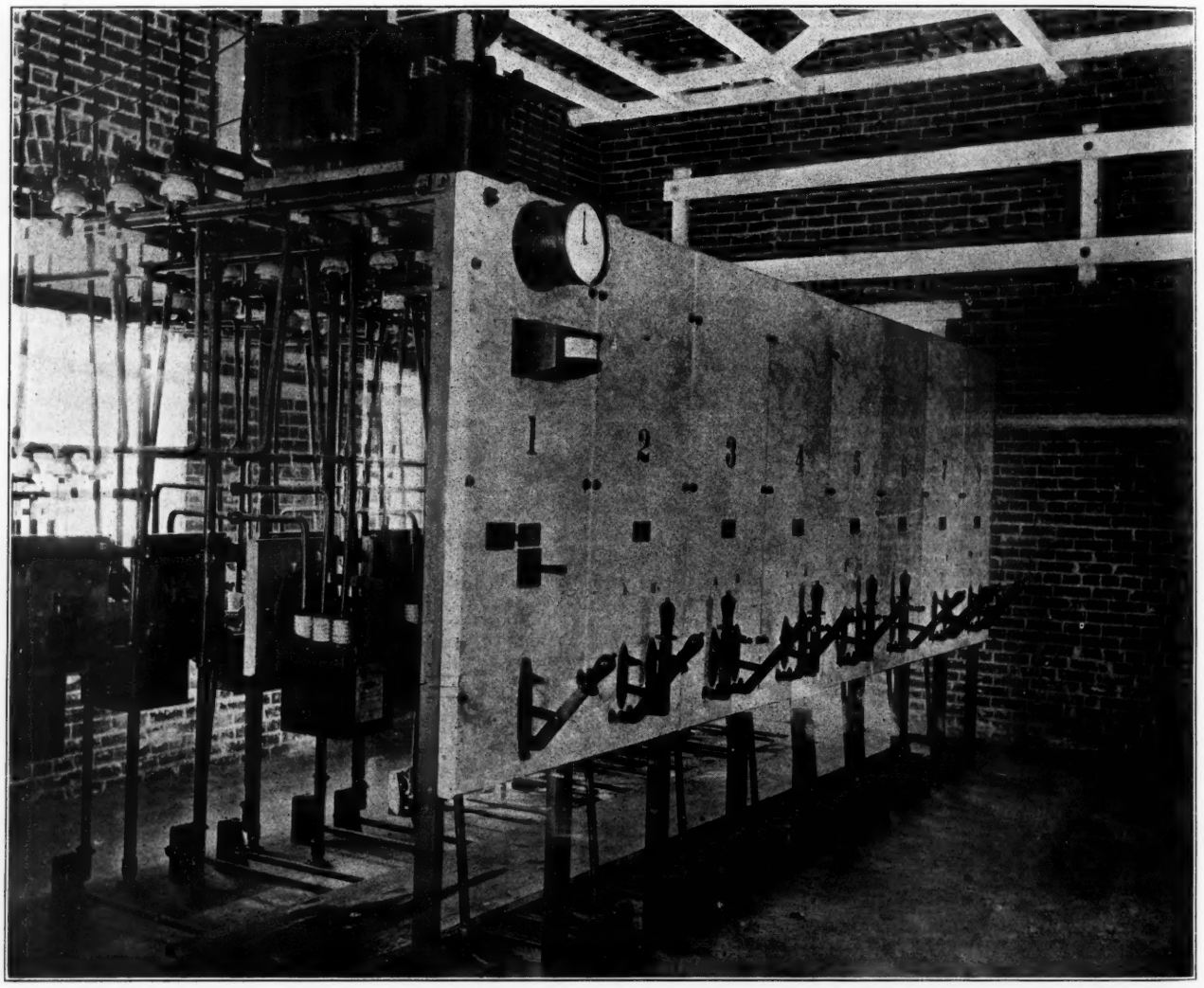
The lighting service is distributed single-phase from the main 2,300-volt bus-bars in fifteen distinct circuits. Each circuit is equipped with a potential regulator, and the regulation is determined by charts which have been established for each circuit by means of tests. The transformers on the distribution are banked in the congested districts, and in outlying districts are so placed that each transformer will serve a moderate area. The distribution system is equipped with lightning arresters, both at the station and at various points on the line.

The arc-lighting system at Colorado Springs and Colorado City consists of six fifty-light tubs, which are supplied from the 6,600-volt bus-bar. These regulators are the 6.6-ampere constant-current regulators.

SUBSTATION "B."

Substation "B," located in Colorado City, between Eighth and Ninth streets, just south of Colorado avenue, is more of a switching station than a distribution station. This substation was installed to take care of four transmission lines meeting at this point, and also to receive the two lines from the Pike's Peak Hydro-electric plant, located at Manitou. This substation contains no transformers except potential transformers, all the lines being at the voltage of the transmission system.

The switchboard at this point consists of an eight-panel marble board, only one of the panels carrying instruments. The bus-bars are arranged in duplicate, and all bus-bars, switches and wiring for the switchboard are carried on a special gas-pipe frame at the rear of the board. Each panel is equipped with two switches, one for each bus, and these switches are interlocking, so that only one switch at a time can be in service on each panel.



SWITCHBOARD, SUBSTATION "B," COLORADO CITY, COLORADO SPRINGS ELECTRIC COMPANY.

The only instruments used in this substation are a voltmeter and a synchronism indicator, to be used in case the bus-bars at this point should be operating on separate plants.

Each line coming into the building is thoroughly equipped with lightning arresters, the arrangement of the lightning

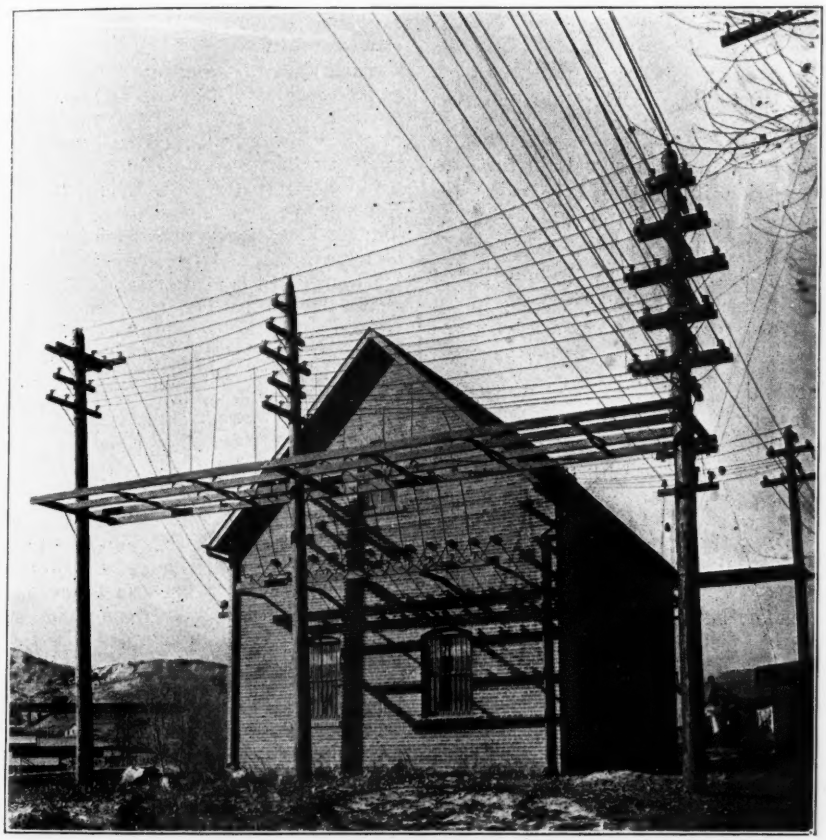
arresters being the same as at the Austin Bluff's plant.

The Standard mill, one of the largest power consumers on the system, is fed from this substation by a single circuit.

The Portland mill, another large reduction mill, has a circuit which branches from the main transmission line close to substation "A," as shown on the map.

The Telluride, which is not now in operation, also has a circuit branching from the main transmission line.

Each of these mills has its own transformer substation, where the voltage is stepped down from the line voltage to 460 volts for motor service. The motors are of both the induction and synchronous three-phase types, and vary in size from five horse-power to 300 horse-power.



EXTERIOR OF SUBSTATION "B," COLORADO CITY, COLORADO SPRINGS ELECTRIC COMPANY.

Each substation at the mills is thoroughly equipped with marble switchboards, oil switches and lightning arresters. The connected capacity in motors at these mills aggregates 4,000 horse-power.

A very accurate record is kept of all power generated, coal consumption and water consumption, along with the incidentals, and all the large power consumers are on meter basis.

INSTALLATION AND MAINTENANCE OF STORAGE BATTERY FOR TRACK CIRCUITS.[1]

BY C. C. ANTHONY.

The storage battery is particularly well adapted to meet the conditions of the track circuit as here outlined. The electromotive force of a single cell is comparatively high, much higher than that of other batteries commonly used on track circuits, and is fairly constant; for, although the range between maximum electromotive force at full charge and the minimum at discharge is wide, the actual variation on discharge in regular service is very moderate. At the same time the internal resistance is so low that it is necessary to use artificial resistance which has the advantage that it can be adjusted to the requirements as exactly as may be convenient and is free from variation.

A further advantage is that one storage battery can be used to supply track circuits and other circuits at the same time; the internal resistance is so small that variations of the current in one circuit cause no noticeable changes in the difference of potential at the battery terminals and consequently no fluctuations of the current in any other circuit. Finally, the storage battery is not seriously affected by very low temperatures and, for the low rates of discharge common on track-circuit signal work, does not require underground or otherwise protected shelters.

The cells can be placed above ground in a suitable cast-iron base of a signal post or in a case or box between the bracing in the leg of a signal bridge. If the battery is charged in place care should be taken to provide ventilation so that the fumes will be carried off and to protect thoroughly any ironwork near the battery; partitions separating the battery from instrument compartments should also be impervious to the fumes.

Where the method of alternate charging and discharging is employed, that is, if duplicate sets of battery are installed and one cell of a pair is charged while the other is supplying current, a simple double-throw multiple switch is used for each pair of cells. When this switch is in one position the two terminals of one cell are connected to the charging circuit and those of the other to the circuit to be supplied, and *vice versa*. If cells at a number of points are charged in series on a special charging circuit, an additional double-throw switch is needed for each pair of cells, by which the charging line may be connected as a loop to the "charging" switch previously mentioned, or disconnected and cut through.

It is a tradition of the track circuit that both the relay and battery should be located as near as practicable to the point of connection to the rails so that the wire resistance between them and the track will be very small. This rule has no application to storage battery, however. Since resistance must be introduced between the battery and track part of this resistance may just as well be in the connecting wires as in coils made specially for the purpose. The battery can therefore be located at a considerable distance from the end of the circuit on the track, if there is any advantage in doing so, and the artificial battery resistance can be reduced by an amount equal to that of the long leads.

The resistances are simple coils of any convenient form; the chief requisite is that the wire and the surface be large enough so that the current flowing when the track is short-circuited will not cause overheating. Where the same battery is used to supply other circuits it may be

[1] Abstract of paper presented before the Railway Signal Association in New York, May 23, 1905.

an advantage to provide the resistance coils with iron cores so that they will act as choke coils to prevent the passage, between the track and other circuits, of discharges due to lightning.

It is usual, in this double use of the battery, to insert two resistances on each track circuit, one in connection with each pole of the battery, so that neither side of the other circuits connected with that battery will be grounded on the track. There is a good deal of doubt in the mind of the writer as to whether there is any advantage in this arrangement; it is a question whether it is not better to have one side of the signal circuits grounded so that an accidental ground on the other side may show itself by cutting out a signal before worse trouble is caused by a combination of grounds on that side of the circuit in which the circuit-breaking devices are connected.

It is practically necessary to settle upon one resistance and use it on all circuits of the same general character. For a single cell of storage battery electromotive force about two volts, a resistance of two ohms is found to be satisfactory with relays adjusted to pick up with 0.015 watt. Where the batteries are used for signal and track circuits two coils of one ohm each are put in. The current taken on short-circuit of the track is of course about one ampere.

Supplying two or more track circuits from the same single-cell battery, especially the long circuits used with automatic block signals, has not proved altogether satisfactory in practice. The principal trouble has, however, been caused by the stray currents in the earth, coming from electric roads. Where two track circuits are practically in connection with each other through the small resistances used with one cell of storage battery, these currents are likely to cause disturbances that would not occur if the circuits were entirely separate. It may therefore be laid down as a general rule that each long track circuit should be insulated on both rails at both ends and should have its own source of current.

The same battery used for a track circuit may, without any practical disadvantage, supply current to insulated signal circuits, although it is safer if these do not extend to any great distance and are not connected to a general common return wire, as perplexing troubles due to grounds at distant points may thus be avoided.

For the actual work of installing the cells the first and last word is, follow the directions. Cells rated at eighty ampere-hours, normal charging rate ten amperes, are quite satisfactory for single track circuits or for one track circuit and one or two signal circuits in connection with it. The chief difficulty, where the method of series charging is used, is to furnish the normal charging current for the initial charge. The current is likely to be limited by the resistance of the charging line to a point below the normal charging current for the battery so that, even though only a few cells are charged at a time, it may not be possible to send that amount of current through them.

The disturbing effect on track circuits of the stray currents flowing through the earth from electric railroads has already been referred to incidentally. If this disturbance were confined in its results to occasional failures of signals in the danger position it might not be cause for very great concern. But when we consider that, where such currents are of considerable strength, so likely a defect as the failure of the insulation in an insulating rail joint may cause a signal to clear with a train in the block, it is evident that the situation is somewhat serious; and as the area covered by electric railroads increases and the volume of return current grows with the increase in number and weight of cars, the danger of "clear" failures of automatic signals from this cause is undoubtedly increasing from year to year. Alternating current, in combination with relays adapted to respond to such current only and to be unaffected by direct current, has of course already been used to a limited extent for track circuits on electrically operated roads; and, unless operation of electric roads by alternating current should have a very rapid introduction, it seems not unlikely that the use of alternating current as a protective measure on the track circuits of steam roads may become urgent in the next few years.

With the alternating current used on the track circuits, one advantage of the storage battery, that of furnishing for a reasonable time a local source of current unaffected by accidents to the power line or generator, would of course be lost, and all efforts would have to be devoted to placing the lines and generating plants practically beyond the possibility of any prolonged failure. The line is the most serious problem, but it is safe to say that, under the pressure of necessity, by thoroughly substantial construction it could be made reliable; although it might be necessary to place it in conduit under or near the surface of the ground. However, the considerations need not as yet withdraw all attention from the storage battery.

The maintenance of the storage battery, to whatever use it is put, is well covered by the directions of the makers. It naturally happens, however, that some differences of method develop in different localities. The conditions on automatic block signal circuits are very favorable for the battery. The cells are chosen of such size and are so handled as to maintain a good reserve capacity against a breakdown of the power line; consequently they are worked at a low rate and are never, in regular service, carried anywhere near full discharge. As a result it is rare that any defect develops and very frequent inspections and elaborate tests seem hardly necessary.

Where the batteries located at automatic signals along the road are charged on a series charging line, it is necessary that charging be done every day so that a good reserve will always be available for emergencies. The principal item of maintenance is then the daily trip of the batteryman to reverse the charging switches; but, as other work can be generally combined with these trips, only a moderate fraction of the batteryman's time is chargeable to battery maintenance. As these regular visits must be made it is common practice to have the batteries tested at each visit; the necessary tests take only a few minutes at each point. Charging is regularly done at night so that the inspecting and changing of switches is done while the charging line is dead.

On the Pennsylvania railroad one hundred and forty-two cells in one group have been in service an average of three and a half years. Other groups have been working for various periods from two years down to seven months. In these 990 cells, with an average service of about a year and a half, six new elements have been used for renewals, three broken jars have been replaced, and four carboys of electrolyte and a small quantity of distilled water have been used on account of evaporation. Part of these cells are of eighty-ampere-hour capacity and part 160-ampere-hour.

Automobiles and Electric Cars for Lima, Peru.

A. L. M. Gottschalk, United States consul at Callao, Peru, states that the Empresa del Tranvia Urbano de Lima (Lima Horse Car Company) will receive proposals from the United States for the material which it intends to purchase in order to transform its present line into an electric trolley road. The company will need some forty-five cars, with a seating capacity of forty persons each. These are to be run by overhead trolleys. It will also purchase wires, rails, transformers, rotaries, etc. American exporters of these classes of goods should address Señor D. Joaquin Godoy, Gerente, Empresa del Tranvia Urbano, Lima, Peru, sending plans and proposals, and not English catalogues merely.

THE CHOICE OF AN INSULATED CABLE.[1]

BY WALLACE S. CLARK.

Every plant generating electric current uses insulated cables—in many cases only for station wiring; in others for its entire distributing system. The company that buys twenty-five or more miles of cable each year can and does devote a liberal allowance of engineering skill to the selection of the best and most economical types. There are a very large number of plants of moderate size that, with the growth of their business and the increasing tendency to substitute underground for overhead construction, are compelled to increase continually their investment in this line. Some of the points covered in this paper will, I hope, be of value to those responsible for the success of such plants.

The size of the conductor is determined by well-known methods, therefore it is only necessary to emphasize some points usually overlooked. There are two distinct conditions of service. One where the amount of current is not subject to any probable increase, such as instrument, generator and transformer leads; the second comprising all lines outside of the station that may be subjected to increasing loads due to the growth of business.

For the first class, ampere (current-carrying) capacity, or mechanical strength in the case of small apparatus, is the determining factor. The current-carrying capacities given in the National Electric Code for rubber insulation are a fairly safe guide and the current densities given should not be exceeded.

For the second class of conductors, the cost of power at the switchboard, the load-factor of the line, the limits of loss in transmission for satisfactory regulation of potential and operation of consuming device, the heating of the cable in short lines, the probable increase in load with time and the interest charge on the cable investment are the principal factors in settling the size of conductor to be used. The Thomson law, so-called—that the most economical arrangement is where the cost of the power wasted and the interest charge on the cable investment is a minimum—is the basis of many formulæ elaborated in different books.

Having determined the size of conductor required on theoretical grounds, consideration should be given one or two very practical points. First, do not use for underground construction cables so small as to be mechanically weak. I have in mind a station with a 6,600-volt distribution where the cables ran from three-conductor No. 0000 to three-conductor No. 6 in size; the No. 6 constituting the smallest part of the installation and giving more trouble than the entire remainder of the system.

Second, if you use a duct system, keep in mind the fact that the cost of duct per foot is independent of the size of the cable in the duct, and select the size of conductors so that the cables will utilize a reasonable proportion of the duct area. Two No. 8 arc-light cables, single-conductor, in a three-inch duct, costing from twenty cents to forty cents per duct-foot, is evidently uneconomical. The standard three-inch duct will take cables of the following sizes, insulated for different voltages: any voltage under 1,500, single-conductor cables up to 2,000,000 circular mils; concentric two-conductor cables up to 1,000,000 circular mils; three-conductor cables up to 500,000 circular mils.

For 3,000 volts, single conductors up to 1,500,000 circular mils; concentric up to 750,000 circular mils; three-conductor up to 400,000 circular mils.

For 6,600-volt lines, which are practically all three-phase, the limit is found at three-conductor, 250,000-circular-mil cable; 12,000-volt lines, the limit is found at three-conductor No. 0000 cable; on 24,000-volt lines at about 100,000-circular-mil cable. It is assumed, of course, that the three-conductor cables are run on delta-connected circuits, and have the same wall of insulation between conductors and ground as between the conductors themselves. If the three-phase circuit is run Y-connected with neutral grounded, then the outer jacket of the three-phase cable can be made considerably less in thickness and larger cables be installed in the standard three-inch duct.

Fig. 2 gives some curves showing the variation in cost per 1,000 circular mils of copper contained in the cable for different sizes of cables and different working electromotive force. It will be noted that the lack of economy in the use of small conductors is most marked in the 15,000-volt class, where changing the size from No. 8 to No. 6 wire increases the cost less than four per cent, while the conductivity is increased fifty-eight per cent. Or, taking the larger sizes and going from No. 1 to No. 0, the cost is increased eight per cent and the conductivity twenty-six per cent.

These figures and curves are based on varnished cambric cable, as this type of insulation is roughly midway in price between good rubber cable and good paper cable. With paper insulation the comparison would be less favorable to the larger conductors, while with rubber insulation the use of the larger conductors would show much greater economy.

There is another point especially noticeable in the use of potentials above 5,000 volts, and that is that the safe working pressure for a given thickness of insulation is less in the very small sizes of conductor. Or, to put this in another way, where the thickness of insulation exceeds twice the diameter of the copper core in high-potential cables with homogeneous insulation, we are not able to get the full advantage of the insulating wall, since the fall in potential, or potential gradient, is undoubtedly higher in the layer of insulation immediately adjoining the copper than it is half way between the copper and the outside of the cable; this concentration of pressure tending to break down first the inner layers of the insulation and finally puncturing the entire insulating wall. In short, it is easier to make a 500,000-circular-mil cable for 10,000 volts working pressure than to insulate a No. 14 wire for the same purpose.

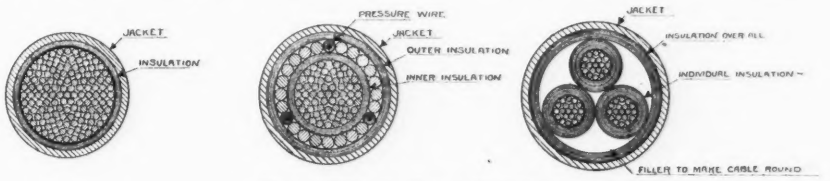


FIG. 1.—THREE CABLE SECTIONS.

The next point to be covered is whether single or multiple-conductor cables should be used. For station wiring single conductors in separate ducts, or runways, might safely be taken as the best modern practice. Maximum safety and reliability, and simplicity of arrangement, appear to have settled this question pretty definitely. For outside lines the service will largely decide. Direct-current railway feeders are normally single conductor.

When ducts are high in cost and the load on one feeder is not heavy enough to require a cable utilizing most of the duct space, two feeders may be combined,

[1] Read before the National Electric Light Association at its twenty-eighth convention, held at Denver-Colorado Springs, Col., June 6-11, 1905.

as long as their course is parallel, in a concentric type of cable if it is desirable to preserve their identities to the switchboard. If it is not important to run the cable as separate feeders back to the switchboard, we may bunch two or more cables by means of a junction box into a single large cable which will run back to the generating plant; as, for instance, three 500,000-circular-mil cables might be multiplied and a 1,500,000-circular-mil cable run back to the station. This cable is readily installed in a standard three-inch duct, and there would be a saving in first cost of cable, a saving in duct investment and in switchboard.

For low-tension mains on the three-wire system, either three single-conductor cables or one three-conductor cable can be used. The three-conductor cable is slightly cheaper in first cost but not nearly as convenient for making taps to customers. Theoretically, with alternating currents there is a slight advantage in the use of the three-conductor cable. For low-tension feeders, which usually exceed 250,000 circular mils in size, the concentric type of cable should be used for maximum duct economy. Smaller than 250,000-circular-mil cables may be run as a flat twin conductor, and this type of conductor is always advisable for alternating-current feeders with manhole transformers. It should be noted here that it is a modern practice, and one to be commended, in running a three-wire system to ground the neutral and run the feeders simply as two-wire feeders, providing a tree or trunk neutral to which the different points of distribution are connected and which runs back by means of a very heavy cable to the station.

The common practice in arc circuits is to use single-conductor cable. Where a number of circuits are in parallel for any distance an excellent plan is to combine them into a multiple-conductor cable. This saves in first cost, in cost of installation, and in cost of ducts. If a number of small leaded cables are run in one duct, which is necessary in order to keep the duct investment reasonable for the arc circuits, one cable burning out in a duct is very likely to injure the others. Further, the cables are liable to mutual injury when being installed, and it is quite difficult to draw out one cable without damaging the others. These are defects that may be avoided if a multiple-conductor cable is used.

Single-phase two-wire lines not exceeding No. 0000 size should be run as twin conductors unless numerous taps are made, in which case the greater convenience in making joints may justify the use of the single-conductor cable. The concentric type of cable for single-phase work is losing favor in England and on the Continent and has never been in favor in this country. The most serious objection is that in a large network of concentric cable on single-phase or three-phase alternating circuits, great care is required in switching, since the outer conductor has a very much higher electrostatic capacity to earth than the inner conductor, giving rise to surging of the voltage and current and to burn-outs. For three-phase work, three-conductor cables, and for two-phase (quarter-phase) four-conductor cables are required, both on economic and engineering grounds.

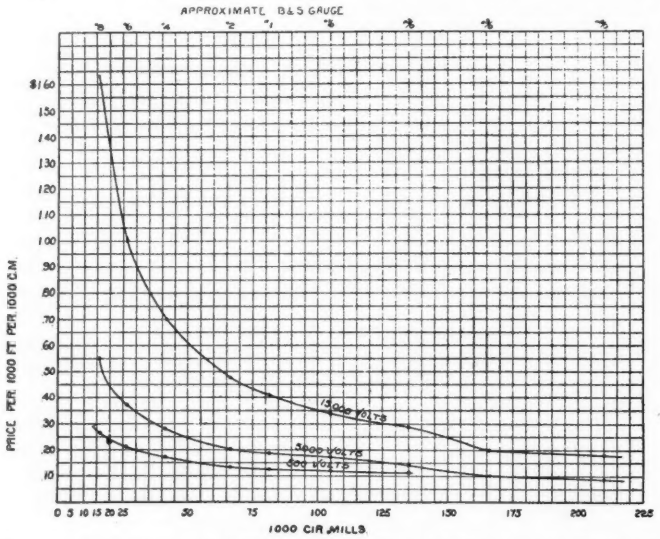


FIG. 2.—VARIATION IN COST PER 1,000 CIRCULAR MILS OF COPPER FOR DIFFERENT SIZES OF CABLES AND DIFFERENT ELECTROMOTIVE FORCE.

Types of Insulating Material for Different Services: (*a*) Station Wiring—I believe the majority of engineers who have had experience in central-station construction now consider that cables without metallic sheaths are better than leaded or other metal-sheath cables for this class of work. The lead sheaths are generally grounded, and must be grounded in a high-tension system to prevent the accumulation of static charge. These grounded lead sheaths offer the arc from any conductor to earth in their neighborhood a ready inducement to spread and cause trouble on adjoining cables. The lead sheath on circuits exceeding 5,000 volts, and on all voltages if the cable is paper or fibrous insulation, must terminate in an end bell or pothead to prevent the breakdown of the cable at the terminus of the lead sheath. This end bell in addition serves as a seal to prevent the absorption of moisture in the case of paper or similar cable.

Cables for tensions not exceeding 750 volts that can be run in dry non-metallic ducts without pocket, where water may collect, or on suitable incombustible insulators—porcelain, glass, slate shelves, concrete, etc.—require insulation only to prevent shocks to operatives and short-circuits due to mechanical causes, such as a workman dropping a wrench or bar across two bare conductors. An excellent type of cable for this work is one insulated with varnished cambric tapes and asbestos (asbestos being on the outside), finished with a flame-proof braid. Such a cable can be operated continuously at the boiling point of water without injury. The varnished cambric, being enclosed in asbestos, does not introduce any additional fire risk, as do weatherproof or rubber cables. The rate of deterioration is less than with other types and the cost low. The first use of this type on a large scale was in the Harrison street station of the Chicago Edison Company in 1893. Since then they have been largely used in station practice and have never given any trouble; they have in one or two cases come through fires practically uninjured.

For pressures of 1,000 volts and upward we must use rubber cables of good quality, or some satisfactory substitute. Such cables, unless protected by individual fireproof runways, should be protected on the outside by an asbestos jacket. This jacket will prevent fire following along the cable or bunch of cables; it also acts as a protection, to a considerable extent, from the destructive action of an arc from an adjoining conductor.

If rubber insulation is used it should be of good quality, and such cables can not be cheaply made, owing to the present extremely high price of the better grades

of crude material. Rubber cables should not be operated at temperatures exceeding 125 degrees Fahrenheit if reasonable long life is expected of the insulation. Lower operating temperatures are most desirable, as they will do much to prolong the life of the insulating wall. Higher temperatures cause very rapid deterioration of the insulation. In England, and to a less extent on the Continent, various patented compounds, made usually from oils and bitumens, have been tried, and with fair success, on low-tension work, and where they are not subjected to any high degree of heat. These cables are not adapted to the high temperatures that prevail during summer in most stations, nor will they give satisfaction when run at the high-current densities common in this country. The best that can be said of these insulations is they are more or less successful imitations of vulcanized rubber and generally have all the faults of rubber insulation more or less exaggerated.

You are all no doubt familiar with the large use of oil varnish films in the insulation of electrical apparatus such as transformers, generators, motors, etc., usually used in combination with some woven fabric to give mechanical support to the film. Six years ago, after extended experience with this type of insulation, the company with which I am connected became convinced of the value of the insulation for cable work, especially on cables of large size or for very high voltages. The insulation developed consists briefly of cloth tapes especially treated and coated on both sides with multiple films of varnish. These tapes are applied to the cable, and between the tapes is a thin film of plastic insulating material which does not dry or become hard. The function of this plastic layer is to increase the flexibility of the cable by allowing the tapes to slide one upon another when the cable is bent. Cables thus insulated are tested and finished the same as rubber-insulated cables with braid, lead or any other desirable finish.

This type of insulation has all the good qualities of paper cables. It will withstand as high temperatures; it is more flexible; has a considerably higher dielectric strength; and finally, most important of all, does not absorb moisture and can be used in interior work without a lead jacket. The varnish and cambric insulation, which we will speak of as V. C. for the sake of brevity, will not decentralize or deteriorate under temperatures destructive to rubber insulation. Mineral oil will not rot it. So far as data are obtainable, its rate of deterioration is less than that of vulcanized rubber of the best quality under like conditions. Its dielectric strength is fully equal to that of rubber insulation. The method of manufacture is one ensuring a homogeneous insulation of uniform dielectric strength—a point extremely difficult of attainment in rubber-insulated cables for high voltages. This type of insulation, I believe, is especially suitable for station wiring in the higher potentials and larger sizes of cables. It lacks only one quality to make it approach very closely the ideal—it is not in itself fireproof; neither is rubber, nor paper. Like rubber-insulated conductors, it may be flame-proofed with asbestos on the outside, or, in fact, with any available material that can be used over the other insulations. It has not as yet been applied to very small conductors for potentials below 1,000 volts; for these rubber is at present the best available insulation. For small conductors for high tension an inner wall of rubber and an outer wall of varnished cambric make an extremely effective cable and one much cheaper than cable built entirely of rubber.

Passing to conductors outside of the stations, these may be roughly divided into transmission lines practically always operated at potentials of 4,000 volts or more and running to substations. The second class of cables comprises the distributing systems with feeders seldom exceeding 3,000 volts and mains to which customers are directly connected operating at 500 volts or less. Circuits outside of the station using insulated cables are practically all underground. There are a few cases where high-tension leaded cables are run on pole lines supported by a steel cable similar to telephone practice, but this may be regarded as a temporary expedient.

Underground construction in this country consists almost entirely of lead-jacketed cables in conduits, the most permanent type of duct being thoroughly vitrified tile. For installations where electrolysis can be guarded against, or is not to be feared, paper-insulated lead cables give thoroughly satisfactory service when carefully installed. Where severe electrolysis is counted on or where the ducts are filled with water for considerable lengths of time varnished cambric or rubber leaded cables should be used to ensure against interruptions of service.

There are some successful installations of rubber cables, not lead-sheathed, in operation. It is, however, questionable if this is the best practice, since the ultimate life of the leaded cables will, I believe, be sufficiently extended to warrant the extra cost of the lead jacket.

Services to customers are installed in short lengths, although amounting to a considerable proportion of the cost of an underground system, and are most convenient when insulated with a material not requiring special sealing of the ends to protect against the absorption of moisture, and it is a common practice to use rubber-insulated cables for this purpose. We believe varnished cambric to be equally well suited to the requirements.

Where subaqueous lines are called for various constructions are possible. With narrow, shallow streams or canals the line of conduits may be dropped with deep manholes and the ducts carried underneath the bed of the stream. This usually necessitates draining the ducts toward one manhole and providing a small pump to keep the manhole clear of water seeping in. Wide shallow streams can have a trench dredged or dug across them and cables with band steel armor laid in the trench which will usually be rapidly filled with silt. For deeper streams or wider streams armored submarine cable is required. A method used with success in some cases is to lay a cast-iron water main with specially bolted ball and socket joints along the bottom of the river and to draw an unarmored leaded cable through it. Tunnels can, of course, be used, but except for a very heavy line containing a number of cables this construction is extremely expensive, and it is cheaper to install one or more spare cables which can be switched into service in case of accident to one of the operating cables. It is perhaps well to mention here that where a submarine cable or underground cable is inserted in a pole line of any length adequate lightning protection should exist at each end of the cable.

There is one type of cable largely used in England, and almost universally in continental Europe, of which we do not avail ourselves as much as we should for underground work. This is the so-called band iron armored cable. Leaded cable is wrapped with tarred jute, over this with two overlapping steel tapes, each from one-thirty-second to one-sixteenth inch thick. The outer tape covers the butt joint in the inner tape and is protected against corrosion on the outside by an additional jacket of compounded jute. Such cables buried directly in the earth have been giving first-class service in some cases for twenty years. They are in use for pressures from 250 up to 15,000 volts.

and lines of even higher potentials have been installed, but for too short a time to be cited.

There are many cross streets where only a distributing main of, say, three No. 0000 conductors is required. A single duct with small manholes every seventy-five feet for service distribution will cost at least fifty cents per duct-foot, including service manholes and omitting all paving charges. Single No. 0000 cables suitable for this use can be armored for approximately eight cents per foot, or twenty-four cents for three cables, showing a direct saving of sixteen cents per foot of three-wire main, allowing ten cents for trenching. If smaller sizes of conductor were used in the comparison the saving of the armored cable over the duct would be largely increased, since the duct charge is fixed, while the cost of armoring is approximately proportional to the size of the cable. With such constructions services can be installed at any point, the joint being protected by cast-iron T-boxes. Such cables are usually installed inside of the curb lines, saving the expense of disturbing expensive pavement. Cables thus installed can run into manholes belonging to the conduit system at either end of the block and be then worked in with the regular distributing system. For service to buildings set back from the street, for an underground system connecting a group of buildings of a permanent character such as a college with fine grounds, where overhead lines are an eyesore, and for complete systems in small cities where the conduit system is too expensive, this type of cable represents a neglected opportunity, I believe, to American engineers.

PROPER REQUIREMENTS AS TO TEST PRESSURES.

Before it is shipped from the maker's factory every cable should be tested with an electromotive force higher than the maximum working pressure. If possible, a similar test should be made after the cable is installed and jointed. As to the relation which these test pressures should bear to the working pressure, the duration of the tests, etc., there exists considerable diversity of opinion. For a good many years the writer has advocated two and one-half times the working pressure for thirty minutes to an hour as a factory test and twice the working pressure for the same length of time after the cable is installed. Cables tested under these requirements have given no indication in practice that the margin of safety was not ample. Some engineers, desiring a higher factor of safety on important and large installations, specify a factory test of three times the working pressure and a test installed of two and one-half times. Any requirement more severe than this represents a questionable investment on the part of the purchaser. It is especially undesirable to make very high potential tests for very short periods of time, since the cable may be decidedly weakened by such treatment, although it does withstand the high-potential test for the brief period specified. In short, the words "breakdown test" should not appear in cable specifications, in the writer's opinion. Boilers are tested to see if they are safe for a given working pressure, but such test is not usually referred to as a bursting test. Cable tests should be considered on the same basis. They are not to show the ultimate strength of the cable, but to show that the cable is safe and satisfactory cable for the purpose for which it is intended.

It should, of course, be understood that the above refers to cables for 2,000-volt circuits or over, since in lower voltages the necessary mechanical requirements frequently call for a wall of insulation sufficient for a 3,000-volt test or even a 5,000-volt test on cables which are to operate at 250 volts. A variation in tests called for by some engineers, which is a very good one, in my opinion, is to test the cable for one hour at two and one-half times the working pressure and at the end of that period to raise the pressure to three times the working pressure for one minute.

Paper cables are not generally tested at more than 2,300 volts for each one-thirty-second inch of wall; rubber cables at 2,500 volts for each one-thirty-second inch of wall; varnished-cambric cables we are enabled to test with 2,800 volts for each one-thirty-second inch of wall. These figures apply, of course, to the ordinary commercial cables as made to-day. They can be exceeded on specially made cables of all types. The size of the cable has a considerable bearing on the pressure test, and the figures above represent the practice on cables running from No. 6 and larger, for working pressures from 2,000 to 20,000 volts.

In concluding this paper I would strongly advise any central-station man who contemplates underground construction to procure a copy of Louis A. Ferguson's paper, read at St. Louis last year at the Electrical Congress, on underground construction, as it contains a mine of valuable information, which, so far as I know, has nowhere else been published.

It is to be regretted that more time and thought have not been given in the past to the selection of the proper types of cable for given uses, as the subject is one which, on account of both its commercial and engineering importance, deserves careful study.

HIGH-SPEED, LONG-DISTANCE ELECTRIC TRACTION.

LECTURE AT THE NEW YORK ELECTRICAL SOCIETY.

The 251st meeting of the New York Electrical Society was held May 24. Mr. Charles A. Mudge, formerly chief engineer of the railway department of the Allgemeine Electricitäts Gesellschaft, Berlin, who took part in the tests on the famous Berlin-Zossen road, lectured on "High-Speed, Long-Distance Electric Traction." Mr. Mudge stated briefly the conditions existing in high-speed traction about six years ago, when the plans for these extraordinary experiments were formulated by Messrs. Ratherau and Schweiger. Continuing, he said, in part:

"As is generally known, these tests were made under the direction of a company organized for the special purpose, and known as the 'Studiengesellschaft für Elektrische Schnellbahnen.'

"The objects of the tests were to make a study of many of the heretofore incompletely, and in some cases, wholly unknown factors entering into electric traction at speeds never before attempted, such as collecting current at high voltages, traction and air resistances, best design of trolleys, motors, transformers, brake gears and trucks, the power required to run at high speeds, the details entering into the construction of the permanent way, and the collection of other data in order to calculate costs of future installations.

"The track selected for the experiments parallels the main line running south from Berlin toward Dresden, and is used by the Ministry of War for giving instruction to the railway corps of the army. The car barn was located five miles from Berlin, at Marionfelde, where the tests were started toward Zossen, fourteen and one-half miles distant, over a track having only two decided curves, of one and one-fourth miles in radius each. The first one occurred three and one-eighth miles from the car barn, the second, seven miles further on, leaving four and three-eighths miles to Zossen. This practically divided the line into three parts—four miles at each end for acceleration, and seven miles for running in the middle—with almost no grades; conditions about ideal for the tests contemplated.

"Power was supplied from a central station seven miles distant, to a cable-house along the line a little over one-half a mile from the car barn, where it was connected directly to the trolley wires

through automatic circuit-interrupting devices.

"The apparatus installed in the Allgemeine car differed quite materially from that installed in the Siemens & Halske car, and my remarks will refer only to the apparatus used in the Allgemeine car.

"The car body was sixty-nine feet long and nine and one-fourth feet wide, and was divided into three compartments by a so-called machine room, twelve feet long in the middle, which contained the starting rheostat and high-potential switches, and was not allowed to be occupied while current was on. The other two compartments were utilized for measuring instruments and for passengers, and were connected by a narrow passage through the machine room.

"On either side of the machine room underneath the car floor the transformers were fastened. The six-wheel trucks were spaced forty-three feet seven and five-eighths inches from centres, and the forty-nine and three-sixteenths-inch wheels had a base of six feet three inches, which was increased later to eight feet two and one-half inches.

"Three-phase current was used, and the highest recorded voltage in the car during any test was 14,150. The current collectors were of the sliding bow form, six in number, and placed in groups of three on each end of the car, two bows working in parallel on each plane.

"The weight of the complete car with fifty passengers was 100 tons (2,000 pounds to the ton), which was increased four tons in the last year of the tests by alterations necessary to accommodate the new trucks and by balancing weights.

"The first year, September, October and November, 1901, was what might be termed a 'try-out' period. The entire installation, with the exception of the permanent way, being new, it was necessarily handled with greater caution than it would have been if the apparatus had been of a more standardized construction. Before the car was taken from the works all apparatus was thoroughly tested, and for this purpose a stationary bed plate, having four run wheels, was arranged under each truck, the wheels on the bed plate having profiles similar to rails, and made wide enough for brake straps of dynamometers.

"After all apparatus had been given as thorough a shop test as possible, the car was hauled approximately 500 miles by a steam locomotive in order to loosen it up. After this many different runs were made, the maximum speed attained during this year's test being 100 miles per hour.

"The second year of the tests, September, October and November, 1902, was occupied mainly in determining the train resistance at different speeds, in measuring the power required for different loads and speeds, in determining the losses to the transmission line, in collecting the necessary braking data for computing the coefficients of friction for different speeds, and in determining the alterations necessary to be made in the car and the permanent way, to allow us to run up to 125 miles per hour.

"These tests were conducted up to a speed of only seventy-five miles per hour, as the observations of the previous year showed that the permanent way would not stand much higher speeds. To determine the train resistance as well as the energy absorbed in running the car a distance of four miles, starting at the car barn, was very carefully measured, and all curves, grades and levels were absolutely fixed. This made it possible to correct the observed data so accurately that the recorded results in this year's report are of the greatest value.

"The brake tests made in this year were not as satisfactory as those in the following year, on account of the complicated brake rigging used, which did not allow of easy adjustment, and which I will not therefore attempt to analyze.

"Suffice to say, that the maximum retardation of two miles per hour per second was recorded at seventy miles per hour, with a total brake pressure equal to 155 per cent of the weight of the car. At the conclusion of the tests this year it was found necessary to build new trucks with a two-foot longer wheel base, and to support the car body on the truck frame at some distance from the centre pin. Also to flexibly support the centre pin in the truck, thereby allowing the car body to have a movement of about one inch on each side of the truck centre independent of it, and in a line at right angles to the track. In order to observe the action of the springs and their connecting levers, it was decided to place them on the outside of the frame of the truck. The tests this year were of value in showing what alterations in the car and permanent way were necessary in order to be able to run at higher speeds.

"Data of very great value were secured on the much discussed question of air resistance, and although the formula may not be straightened out to suit everybody, we know positively that if we run our car, for instance, fifty miles per hour we can expect a maximum air pressure of about seven pounds per square foot at the front of it; and if we double the speed we will get four times this pressure, and if we triple the speed we will run into trouble and get nine times this pressure. If we shape the nose of our car properly we will be able to reduce these figures ten per cent. Also if we run our 100-ton car fifty miles per hour on a level track without paying much attention how the front of it is shaped, it will take about 150 horse-power. When we double the speed it will take six times this amount of power; but if we attempt to triple the speed, *i. e.*, to run at 150 miles per hour, we would have to supply about eighteen times the amount of power it takes to run at fifty miles per hour.

"As had been anticipated, the new truck used this year, with its greater wheel base, worked much more satisfactorily than the old one. The feeling that the car body was being carried along by something that knew its business came to all who took part in the tests, and the sense of security when running at high speeds around curves was a comfortable one.

"That was due not only to better designed trucks, and the manner in which the car body was supported on them, but also to the excellent service given by the new eighty-two and one-half-pound rails, the closer-spaced ties, and the more substantial ballast. At the very outset of the tests considerable difference was noticed in the behavior of the car when running above or below 100 miles per hour. At about this speed the car seemed to take on a swinging lateral motion, which at times became so pronounced that it endangered the overhead work, and created a feeling of insecurity in the passengers.

"The cause of this was found to be the unsymmetrical disposition of the motors and transformers on the car. This was ascertained by taking the weight of the car under each wheel, which showed a maximum variation of one and one-half tons in some cases.

"This was counteracted by placing weights along the floor of the car, four and one-half feet from its centre line at each truck, after which no further vibration was noticed, even up to the highest speeds, and the car ran as smoothly as our Pullmans.

"The working of the trolleys was satisfactory after they had been properly adjusted, but it was evident that a more substantial construction would have to be adopted on installations where schedule speeds must be adhered to.

"The enormous brake pressures needed at high speeds to give a comparatively low retardation, show very plainly that our familiar friend, the coefficient of friction, is not going to help us in the same proportion that he is doing at present; but if he

doesn't electrical means will most likely help us out. For instance, it was found to take about seven-eighths of a mile to stop the car when running 110 miles per hour, the initial brake pressure being 150 per cent of the weight of the car. If we had some means of keeping the retardation constant, we could have stopped the car in three-fourths of a mile by using the same pressures. Under the most favorable conditions the car could not have been stopped in less than one-half mile when running at 110 miles per hour, which would require a retardation of three and one-fourth mile per hour per second, which is about the limit of braking with this type of braking apparatus. The pre-eminent value of the braking system employed lay in the fact that it never failed in its operation during all the tests made, and the feeling of security which its absolute reliability inspired.

"Basing our ideas upon some of the observations and experiences gained in these tests, we would make use of the following points in approaching a similar problem:

"(1) Keep the car body as near the rails as possible.

"(2) Arrange all heavy pieces of apparatus so that their centres of gravity lie in the centre of the car, or symmetrically placed to it, and as near the earth as possible.

"(3) All apparatus mounted above the car floor should be as light as their design will permit.

"(4) Make the overhead trolley contact above the car, in preference to the side of the car.

"(5) Support the motors flexibly on the axles of the trucks.

"(6) Give the front end of the car a wedge shape.

"(7) Support the car body on the truck frame at some distance from the centre bolt, and allow it a flexibility in a line at right angles to the track, independent of the truck.

"(8) Make the total wheel base of the truck of ample dimensions, and not less than twenty per cent of the length of the car.

"(9) Build the road as straight as possible, and where more than one track is used make them further apart than our present practice would suggest.

"(10) On curves, make the approaches of the elevated side of the track longer than usual.

"If it were possible to have the wheels along the sides of our cars and the rails between the floor and roof lines, we should have very comfortable traveling. Any condition approaching this, as by keeping the car body near the rails, would share in the benefits thus derived.

"A German engineer of considerable prominence has advocated lowering the floor of the car between the trucks, in order to make it ride steadier, utilizing the space above the trucks for second and third-class passengers, or for freight and baggage. Although this might be too radical a change in designs of our standard practice, and would not harmonize as well with conditions here as with those abroad, it would undoubtedly give good results. That all apparatus should be symmetrically mounted in relation to the centre line of the car was very evident as we approached the 100-mile-per-hour figure. Our motors were mounted slightly out of the centre line of the truck, and it was found necessary to use 275 pounds per motor to counteract this.

"The transformers, which weighed three and one-half tons each, were mounted on either side of the centre line of the car body just behind each truck; and a line connecting their centres of gravity did not coincide either with the transverse or the longitudinal centre line of the car. This gave rise to a torsional movement which produced a dangerous swinging of the car when running above the speed referred to, which was overcome by placing weights of about one ton each on the side opposite to that to which the transformer was mounted. The fact was thus confirmed that heavy pieces of apparatus should be mounted in the centre lines of the cars for high-speed service, as they run smoothly only when their weight is equally distributed upon the wheels.

"All apparatus above the car floor should be light. This applies particularly to the trolley construction. If the trolley for high-speed work is to be of a light construction, which is the tendency of most designs abroad, particular attention must be given to the form of the exposed surfaces, on account of the high air pressure, and means must be applied to counteract it. When the current is collected at the side of the car, as in these experiments, any slight swaying of the car is at once felt by the trolley, and the higher the current collectors are placed from the ground the greater is this disturbance. Also the trolley wires as placed in these tests were very sensitive to cross winds, and even to the slight pressure of the sliding bow against them, necessitating spacing the supporting poles closer together than they were originally placed, and stretching the wires themselves with very high tensions.

"If the motors are direct-connected to the axles, a part at least, of their weight should be flexibly connected to it. Motors of this power—250-horse-power normal rating—run into weight, and, both on account of the permanent way and the truck, as much of their weight as is possible should be flexibly supported on the axles. This flexibility need not be great, and can be through the medium of heavy springs. There is a certain oscillation given to all the parts on a car moving at such high speeds, and it often occurs, through the unevenness of the road-bed, of slight inequalities in the rails, or the motion of the car itself, that a certain oscillation of a heavy piece of apparatus will be met out of step. For instance, the motor will be going down just as a part of the rail is coming up and a severe blow will be the result. A little flexibility of these parts will greatly reduce the force of this blow. At speeds over 100 miles per hour it very often seems as if the rolling friction were taking a rest, and that we were actually floating for short distances, after which we notice very distinctly that gravity has not forsaken us, and we can almost hear the rails groan under their extra burden.

"It is at such times that the flexibility of the apparatus is mostly needed; not so much when we pass over rail joints or frogs, as the car doesn't take much notice of them and is far beyond before their effects could be felt; but just at those moments when the apparatus seems to be furthest out of synchronism with the car.

"Since it is impossible to build an absolutely level and straight track, we can help conditions very much, as well as increase the comfort of passengers, by having heavy pieces of apparatus flexibly supported in the car.

"Giving the car a wedge-shaped construction may not be possible when using the vestibuled type with multiple unit control, and no definite end relation, in which case it may be advisable to have a portable wedge-shaped engineer's cab on wheels, capable of being quickly attached to the front of the car in making up the train.

"We found that it was a very good thing to hold the car body firmly to the truck frame at points equally distant from the centre pin, also to allow it a movement independent of the truck, parallel with the axles. The trucks take curves much more quickly than the heavy car body, which requires a certain amount of time to swing it out of its straight line path, and should not be attempted too rapidly.

"It should not receive a blow to turn its nose in the new direction, but a gradually increasing pressure until it is turned out of its former course. This was very

well accomplished by the centre pin bearing being mounted flexibly in the truck. The pin was held in its middle position by one and one-half tons pressure, and could be moved out of this position for one and three-sixteenths inches to its furthest limit, by the addition of about two and three-quarters tons pressure. This had the effect of swinging the car body more gradually into the direction taken by the trucks, and the shock was considerably less than that experienced with the trucks used in the first year's tests.

"If we build our roads with few curves, we might as well take full advantage of the fact, and make our wheel base long. The thirty per cent increase of base in the truck used in the last year's tests was a noticeable improvement over that used in the previous tests. With a greater distance between wheels we have a better chance to equalize the weights upon the axles, since the lever arms and springs between them may be made longer and consequently more sensitive and easier to adjust. In three-axle trucks the motors will most likely always be mounted on the outside axles, making it necessary to carry a greater percentage of the weight of the car body on the middle axle, than is carried on the outside ones.

"As this weight fluctuates considerably this fact must not be overlooked in designing the equalizing lever arms of the truck, as otherwise the load will be unequally distributed on the axles and possibly disturb the smooth running of the car.

"In passing stations at 125 miles per hour it was not possible to recognize persons standing upon the platforms, and only those at a distance of fifty feet and over could be approximately identified. On dark and rainy days it was quite impossible to read signals at this speed, except when of large dimensions or of very pronounced color.

"This would suggest placing the signals in the car itself, operated electrically, either by direct contact or through inductive means. Such a system was tried at Zossen and worked perfectly, even at the highest speeeds.

"An insulated piece of angle iron was placed alongside of the rail, it and the rail constituting two poles of an electric circuit. As the car passed over this section contact was made with the angle iron by a brush which led current through a magnet in the car, releasing a spring and allowing a disc to fall in front of the motorman, the circuit being completed through the wheel.

"A system on similar lines could easily be arranged to ring different bells, or to operate different colored discs in the engineer's cab, thus relieving him of the strain upon the eyes caused by passing so many objects which naturally distract his attention.

"In all the runs, of which over 300 were made, no difficulties were met with, or even suggested, that the skill of the engineer did not or could not overcome, and this great triumph, in a branch of industry which has done more than any other to lift the human race to a higher degree of intelligence, should serve as a stimulus to us, who are anxious to have trains in regular service running at this, the highest speed ever attained by any device used for human transportation, 131 miles an hour."

DISCUSSION.

Mr. Sprague—It seems to me that there are two questions suggested by the Zossen experiments:

(1) To what extent will the commercial possibilities warrant speeds anything like those attained?

(2) Assuming that for long distances alternating current be used, shall it be by the polyphase method as at Zossen, or in a single-phase development?

One thing must strike everyone who has followed Mr. Mudge's most interesting description, and that is the extraordinary difficulties which had to be met, and the great increase of powers as the speed approached the higher marks. My own impression is, taking into account all the practical conditions surrounding trunk-line construction and operation, a maximum speed of about one hundred miles an hour is all we can reasonably, for a time, at least, try to reach. Not that cars can not be operated at higher speeds; but the difficulties which must always stand in the way when we take into account all the essentials of trunk-line operation, seem as yet to hardly warrant the commercial use of such speeds. This is a feeling which I have had for a number of years, and I believe it is one which is generally shared by both electrical engineers and steam road operators whenever they have fully studied the matter.

These conclusions, of course, do not vitiate or belittle in any sense the importance of the experiments which have been made, because, in order to operate even at 100 miles an hour as a maximum it is desirable to make trials at much higher speeds, not only to develop weaknesses of apparatus, but to clearly indicate the practical working difficulties and limitations which confront the engineer.

Mr. Mailloux—It seems to me that these tests prove all that was intended. In regard to the selection of systems when it comes to traveling over fifty miles an hour electrically, while it seems as though we should use some alternating system, I am not prepared to say which should be used. The single-phase has not yet been developed to sizes which will do what the large polyphase motors can do. Before we can authoritatively say what would be the best method, further experimentation will be required. I do not think that that point will be reached immediately. The experiments now being made on the New York Central and Pennsylvania roads will give us some valuable data. I am not prepared to say, and I don't think any person is, that they will bring about any real general solution. They are, in reality, what mathematicians term "particular solution." We have something to learn before the electrification of steam roads in general is an accomplished fact. We shall have to proceed gently. I do not wish to be understood as being pessimistic; I believe it is going to come; but by evolution rather than by revolution; not to-morrow, or in ten days, nor, possibly, in ten years. I believe there will still be steam locomotives twenty-five years from now.

Mr. Sprague—I quite agree with the general statements which have been so clearly made by Mr. Mailloux. We are not on the eve of the general conversion of steam-operated roads. It is interesting to note that some of the difficulties met with on the Zossen line at high speeds were encountered in the earlier tests on this locomotive. Notwithstanding the fact that it had leading trucks, there was a distinct "noseing," caused by lateral sway, which was periodic, *i. e.*, corresponding to the length of the rails, and resulting in some displacement at thirty feet intervals. It was thought, at one time, that possibly the low centre of gravity was the cause of this; but this, apparently, did not prove to be the case, for, by using side springs, and subsequently, in addition, friction plates, to retard the free action between the body of the locomotive and its pilot trucks, this "noseing" was made to entirely disappear, even when traveling at the rate of eighty-two miles an hour. Had the potential been raised I have no doubt that speeds of between ninety and 100 miles an hour could have been easily made.

Speaking, however, of the general problem, we must bear in mind that what is being done in New York relates to congested terminal operation, and there are many local conditions which have dictated the use of electricity without necessarily putting it on all points on a directly competitive basis with steam operation. One

of the earliest applications of electrical operation in miscellaneous roads is likely to be due to the recognition of the fact that in many cases the concentration of grades and electrical operation, in whole or in part, at such grades, may prove cheaper than the making of costly detours. In such cases, both continuous and alternating-current motors can be used, and which shall be the better is a matter to be decided by local conditions. In spite of the admirable work which has been done abroad with the polyphase system, and granted its possible desirability in certain special cases, I can not but feel that, speaking generally, the multiplicity of conductors will stand as a bar to any general application to trunk-line service, and that the later developments in single-phase operation, offer, on the whole, more promise of final adoption, where alternating currents are used.

Mr. Shepard—We have a locomotive in operation at East Pittsburg, upon a specially equipped track, about four miles long. We last week put this locomotive in operation, pulling a fifty-car freight train, for the benefit of the visiting members of the International Railway Congress. This locomotive is designed for the heaviest work. Its weight is 135 tons, its capacity 1,600 horse-power, the maximum drawbar pull being 80,000 pounds. This has been registered on the tests already made. The overhead construction is the catenary type and the voltage in use is 6,600. The control of this is by induction regulator. This is quite the ideal control for such service. The tests demonstrate fully the practicability of the single-phase motor of this capacity. The results were fully up to expectations. The tests seem to show that this type of locomotive will find its field in heavy service where concentrated powers are required, as, for instance, on pusher grades, which under steam service are most expensive to operate. In order to secure concentrated power with electrical operation the track conditions need be no more severe than for comparatively light steam locomotives—this by reason of the facility for distribution of the motive power over different axles. I agree with Mr. Mailloux and Mr. Sprague that the adoption of electricity on steam railroads will be gradual; at first, in such special applications as this locomotive is fitted to meet, and such terminal propositions as local conditions determine; and, ultimately, the expansion of these installations will be quite readily accomplished where the high-voltage single-phase system is used.

Transportation Arrangements, Convention of American Institute of Electrical Engineers.

For those attending the convention of the American Institute of Electrical Engineers at Asheville, N. C., tickets will be issued at all the principal stations and ticket offices of the Trunk Line Passenger Association, the Central Passenger Association, the Southeastern Passenger Association, and the New England Passenger Association, on the certificate plan, which allows the holders of such certificates to purchase tickets from Asheville to original starting point, at one-third the regular fare, provided there are at least one hundred certificates presented.

Tickets at full fare for the going journey may be obtained three days (exclusive of Sunday) prior to the meeting, and also during the first three days of the meeting. The scheduled dates of the meeting are from June 19 to 23; consequently, tickets may be obtained not earlier than June 15, nor later than June 21. The outgoing tickets are good on any train which carries passengers to Asheville.

Persons attending the meeting should be sure to make application for their certificate when purchasing ticket for Asheville. Should certificates not be available at the office where application is made, a ticket should be purchased to the nearest station where such certificates are issued, and a ticket to Asheville, together with the certificate, obtained there.

Immediately after arrival at Asheville, persons attending the convention should present their tickets to be viséed at the Secretary's headquarters in the Battery Park Hotel. A fee of 25 cents will be charged by the railroad agent for each certificate endorsed by him.

It should be noted that members must return to the starting point; otherwise there will be no reduction in the fare. No claim for refund will be entertained by the railway companies on account of holders of certificates returning to original starting point, before the requisite number of one hundred certificates is in the hands of the special agent of the railways.

Return tickets at the reduced rate of fare are valid for three entire days after the Convention adjourns, not including Sunday; that is on any through train leaving Asheville before midnight on June 27.

SPECIAL ARRANGEMENTS.

Arrangements from New York—All Rail.—Members starting from New York should leave via Pennsylvania Railroad, Cortlandt or Desbrosses street ferry at 4.30 p. m., West 23d street ferry at 4.25 p. m., Saturday, June 17. If a sufficient number warrants a special train from Washington to Asheville, Saturday night, June 17, it will be provided; if not, extra cars will be attached to the regular train leaving New York at the time mentioned above, Washington at 10.45 p. m., and arriving at Asheville Sunday afternoon, June 18.

Members who wish to leave New York for Asheville Saturday, June 17, or to board the train at Philadelphia, Baltimore, Washington or any other point en route, should communicate with Mr. F. C. Bates, Chairman of the Committee on Transportation and Arrangements, 44 Broad street, New York, immediately, in order that proper provision for special train or extra cars can be made.

Tickets will be sold via Old Dominion Steamship Co., New York to Norfolk, thence via Southern Railway to Asheville on the certificate plan at the following rates: going fare, $18.95; return fare, $10.15; both including meals and berth on steamer.

Old Dominion steamers leave Pier 26, North River, New York, at 3 p. m., daily, except Sunday, and arrive at Norfolk about 11 a. m. the following day. The Southern Railway runs through sleeping cars, leaving Norfolk 7.30 p. m., and arriving at Asheville at 1.40 p. m. the following day.

Members wishing to travel via Old Dominion Steamship Co., should make application for accommodation immediately, direct to Old Dominion Steamship Co., Traffic Dept., 81 Beach St., New York city.

Merchants' and Miners' Steamship Co. from Boston.—Boston members can reach Norfolk by Merchants' and Miners' Line; round trip, including meals and berth, $22.00.

Tickets via Southern Railway Co., from Norfolk to Asheville, can be purchased on the certificate plan as explained above.

Chicago, St. Louis, etc.—Members who wish to start from Chicago, St. Louis, etc., should apply for additional information to Mr. John H. Finney, member of Local Committee, National Bank of Commerce Building, St. Louis, Mo.

The hotel rates at the Battery Park Hotel and at the Manor range from $3.50 per day for single rooms without bath to $4.50 per day for a single room with bath. For double rooms the rate per person is about $1.00 less in each case. Rates at Margo Terrace are $2.50 per day.

All the above rates are on the American plan. Each member must arrange for his own hotel accommodations, and early application is desirable.

Electrical Notes from Europe.

By Our Special Correspondent.

LYONS is to have an additional supply of current from two different sources. The first of these is a large hydraulic station at Moutiers, and the second consists of a plant on the Romanche river at Gavet. This current is needed for operating some of the new traction lines and to provide for the increase of traffic on the old ones. The Moutiers plant is of special interest, as it is one of the few in Europe which will be operated on the direct-current series system at high voltage. It is to be equipped on the Thury system, like the St. Maurice-Lausanne plant, which attracted so much attention. The line is 110 miles long and is the longest in Europe. A tension of 57,000 volts will be used. This is much higher than the St. Maurice, which has only 22,000 volts, and the line is but thirty-five miles long. Thury direct-current machines to the amount of 5,000 horse-power will be placed in the Moutiers station, using four pairs of double dynamos. The 110-mile line from Moutiers to Lyons will consist of two bare copper wires for the overhead part. Where it enters the city there will be two underground cables, well-armored and insulated so as to take 50,000 volts. At Lyons it is proposed to erect a substation containing five double motor-and-dynamo groups, in which the current will be changed to low voltage for the tramways. The high-voltage direct-current system is no longer an experiment, as the Thury system is now working in several large transmission plants. The second plant which is to supply current for Lyons is operated on the three-phase system, with an overload line ninety miles long. The Romanche river affords a 200-foot fall, and it is expected to utilize some 10,000 horse-power. At Gavet there will be three turbo-alternators of 1,700 kilowatts each. They will furnish current at 4,000 volts, running at 380 revolutions per minute. Schneider & Company, the well-known French metallurgical firm of Creusot, will supply the outfit. At Lyons, the substation is to have five rotary converter groups of 600 kilowatts each. When it is finally completed, the new Lyons system will be one of the most extensive in Europe.

Recent experience with motor-boats in France and elsewhere in Europe shows that the magneto which is used for the motor ignition is a great cause of trouble. Thus, at the races which were held in the bay at Monaco, the boats shipped water even in a light sea, and as the magneto was not protected it soon became useless. This not only causes the boat to stop, but as it can no longer be steered, it is liable to turn broadside to the waves and be overturned. As the magneto is to play such an important part in the motor-boat question, it seems only rational that some attention should be paid in the future to having it well enclosed and constructed so that it will give a minimum number of accidents from this cause.

The question of having a better telephone system continues to be agitated in Paris. At present the defects are many and the subscribers have been complaining for a long time past, both as to the working of the instruments and also the way the service is carried out. Some time ago a subscribers' league was formed, composed of many influential persons, in order to defend their interests. This agitation now seems to have borne fruit, for we hear that M. Berard, the secretary of posts and telegraphs, has formed a technical commission which is to examine the different propositions relating to telephone matters, especially as regards the transformation of the existing system. This commission is to meet shortly. It will be occupied with the modifications which have already been undertaken for improving the operation of the lines, as well as the new propositions which have been presented to it. So that there is some hope that in future Paris will have a telephone system which is at least as complete as that of the other large cities of Europe.

The cantons of Schwytz and Zürich in Switzerland are taking measures to secure a supply of current from hydraulic plants and distribute it throughout the region. The city of Zürich expects to thus have an important increase of current, and this is needed to provide for the increase in the lighting and tramways. The two cantons have now made an agreement as to the best method of proceeding. The first plant which will be used for the purpose is located on the Sihl river in the canton of Schwytz. Here it is proposed to build a dam some ninety feet high and 350 feet long across the stream. This will form a large lake in the valley through which the stream flows, and it will have an area of two square miles and a capacity of ninety-six million cubic metres. It will empty into the lake of Zürich, with a difference of level equal to 480 metres. This will afford some 20,000 horse-power, or if the supply is only used for ten hours, it will be increased to 45,000 horse-power. This will be amply sufficient for the present needs.

A new electric process of treating peat is to be used by a large company which has been lately formed in Switzerland. A plant is to be erected at Berne or nearby, in which the peat, as it comes from the bogs, is to be put through an electrolytic process. The method, which is operated by the Osmon company, has been patented recently. The company is said to be capitalized at $400,000. This is only one of the electrolytic methods of treating peat which are now being operated in Europe, as several inventors have brought out different processes. After the treatment, the peat is compressed into briquettes and forms a good combustible.

An exhibition of acetylene apparatus is to be held at Paris under the auspices of the Union of Carbide Manufacturers. It is intended to bring out the merits of new apparatus, so as to be able to select those which show the best qualities of reliability, economy, good workmanship, etc. The society is to examine all the apparatus carefully and will make out a report in which it recommends the best ones. Such a recommendation will, of course, be of great benefit to the inventors. The examination is to be made by a committee of influential scientists and the jury will be composed of delegates of the different industrial syndicates which are interested in the acetylene question.

The new Bourgeat system of electric line poles is attracting some attention. It has been recently used in Switzerland. The poles are built of wood combined with cement. A wood pole or rod forms the core. In it are fixed angled or double spikes and upon them is wound a sheet of wire gauze of large mesh, thus leaving a space between the wrapping and the wood. A cement layer some two inches thick is put over the gauze, and this is found to make a solid pole which is not easily acted upon by the weather. It lasts as well as an iron pole and costs only half as much. A line over thirty miles long

has been erected with the new poles. At present the cross-arms are fixed to the pole by curved iron pieces which are bolted so as to embrace the pole. Later on, it is proposed to make the cross-arms also of cement construction. At Zürich the municipality is trying the new system on a circular line in which the poles are spaced some forty-five feet apart. These poles measure 315 millimetres in diameter at the base and 200 at the top, and are twelve metres long. They have 1.6 metres planted in the ground. They showed a very high resistance to the breaking strains applied at the top. The maximum bending was sixteen centimetres.

Among the new turbine stations we may mention the plant which has lately been erected at Caffaro. This plant is one of the large ones of northern Italy. It lies in the province of Brescia, near the Austrian frontier. The town of Brescia receives current for light and motors over a line thirty miles in length. A high tension of 40,000 volts is used on this line, and no difficulty is found in operating under these conditions. The hydraulic station is equipped with alternators of 1,850 kilowatts and the total output of the plant is near 10,000 kilowatts. Besides the main substation at Brescia there is a second one which has machines of 2,400 kilowatts for supplying direct current to electrochemical works.

At Naples a project is on foot for obtaining current from the Volturno, a stream in the neighborhood. It is proposed to erect a hydraulic station which will furnish upward of 2,000 horse-power. The water will be brought from the intake canal by three steel penstocks having a capacity of 270 cubic feet per second. It is estimated that the hydraulic work and the station will cost some $800,000. From the station an overhead line is to run to Naples, working at 45,000 volts. In the city there will be a large substation for transforming the current. The expense of building the line and substation is figured at $750,000. The total cost of the project will thus be near $1,600,000.

It is stated that the hot-wire principle has been applied to a mirror galvanometer by M. Schmidt, a German scientist. He can thus measure alternating current of very high frequency and with considerable accuracy. The instrument he now uses is an adaptation of the usual hot-wire galvanometer, except that he removes the index needle from the pulley over which the wire passes, and instead fixes a small mirror on it, so that a very slight movement of the wire is shown. Of course great care must be taken in making the readings with such an instrument. He finds that to have its work constant, the maximum current must be applied to it for several minutes before using. One form of instrument with fine wire measures currents from 0.1 to 0.2 ampere. It is heated up for two hours previous to taking the readings, and the latter are found very constant. The difference between any two readings is not more than three-tenths of one per cent. Without the preliminary heating the difference is greater.

Professor Wedding seems to prove in some recent experiments that the blackening of lamp bulbs has not as much effect in cutting down the light as might be expected. He took some lamps that had been running for 14,000 hours and were very much blackened. The candle-power had fallen from sixteen to five candle-power. Upon opening the lamps and replacing the bulbs by new ones he found that they still gave about the same low candle-power. It would seem, therefore, that the lowering of the light is due to the burned-out filament and not to the blackening. While the experiment requires some care to carry out, it is one which can be easily verified, and therefore there does not seem to be much doubt as to the above results.

That the new steam turbines are capable of running for a long time without wearing out has been shown very well at the Donnersmark mine in Silesia. A Brown-Boveri-Parsons turbine had been in operation for two years, with an actual run of 17,200 hours. On the twenty-fourth of April it was taken apart and showed no trace of wear, either in the bearings or the vanes of the wheel. This speaks very well for the performance of these machines. The present wheel must have made over three billion revolutions during the two years' working.

One of the largest arc searchlights in Europe is now in construction for the Russian government by the Siemens-Schuckert Company. It has an arc lamp which takes about 200 amperes and furnishes 310 million candle-power. A parabolic mirror of silvered glass is used here, measuring over six feet in diameter. The carbons of the arc are 4.9 and 3.5 centimetres in diameter. The Heligoland searchlights, which have been reckoned as among the most powerful, give only thirty million candle-power, taking thirty-five amperes, while the mirror is thirty inches in diameter.

According to the opinion of L. Vogt it is a mistake to take account only of the hardness of water when considering the matter of boiler corrosion. Other substances in the water are just as hurtful. After purifying the water by the present methods there usually remains a large quantity of sulphate of soda in the water, and this becomes more and more concentrated as time goes on. The sulphate is found to attack the boiler considerably. Nitrates and chlorides are also found in the water, and these are even more corrosive than the sulphate. Worst of all is chloride of magnesia. We must therefore keep the concentration down below the limits where the salts attack the iron. Seeing that the water is not mixed uniformly in the boiler, the concentration is apt to occur where the evaporation is greatest, or at the points of greatest heat in the boiler. These points are attacked before the others. He recommends emptying the boiler once a week, and washing it thoroughly every two months so as to avoid the accumulation of soluble salts.

The Allgemeine Electric Company has gone somewhat extensively into the manufacture of standard types of lifting magnets for handling iron in various forms. These have been found very convenient in connection with cranes. For short and heavy pieces of metal they employ a magnet of round section, while they adopt an oval section for picking up the longer pieces, such as bars, etc. For plate iron another form is used, and it will take plates up to two inches thick. Another type for lifting rails has movable pole-pieces. It takes some three kilowatts and will lift a six-ton rail. In some of the other forms, the magnet weighs 900 pounds for lifting a weight of two tons or more.

The new electric traction system of Genoa is no doubt one of the most complete in Europe. It runs within the city and to the different suburbs. The rolling stock consists of forty-five-place cars and a second type containing twenty-four places. Both of them use a thirty-horse-power motor with single reduction. The air-brakes work on all four wheels. The heaviest grades on the lines are eight per cent. A 500-volt overhead line is employed. The system now uses about 200 motor-cars and thirty trailers.

C. L. DURAND.

Paris, May 23.

The Faraday Society.

The fourteenth ordinary meeting of the Faraday Society was held on Thursday, May 18, 1905, at the Institution of Electrical Engineers, London, England, Dr. F. Mollwo Perkin, treasurer, being in the chair.

Dr. T. Martin Lowry read a paper entitled "An Application to Electrolytes of the Hydrate Theory of Solutions."

The object of the paper is to consider the possibility of extending the hydrate theory to electrolytes in such a way as to take account of the observations which form the experimental basis of the theory of electrolytic dissociation. The hydrate theory postulates that an aqueous salt solution consists of a mixture of hydrates in equilibrium with the solvent and with one another. But it must be supposed that even in solution there is a limit to the possibility of hydrate formation, so that ultimately a stage will be reached at which the molecule as such will be unable to combine with any further quantity of water. The ionization of an aqueous electrolyte consists essentially in a further process of hydration whereby the fully hydrated molecule combines with an additional quantity of water to form two or more hydrated ions. The hydration of the ions is thus conceived to be the primary cause of the ionization of aqueous electrolytes. It is believed that this extension of the hydrate theory to the phenomena of electrolysis may help to remove the fundamental difficulty of Arrhenius's theory, namely, the absence of a motive for electrolytic dissociation.

The evidence in support of the hydrate theory of ionization is summarized as follows:

(1) The theory is in accord with the fact that the best "ionizing" solvents are those which are themselves most highly associated. While Arrhenius laid special stress on dissociation as the characteristic feature of the process of ionization, the hydrate theory emphasizes an association of solvent and solute which is the primary cause of the separation of the ions. Such an association with the solute may be expected to occur most readily in the case of solvents composed of molecules having a high coefficient of association.

(2) Complete ionization is possible only in presence of a very large excess of water, that is, under exactly those conditions which are most favorable to the formation of complex hydrates.

(3) The influence of temperature on ionization is also in accord with the view that the process is essentially one of association with the solvent.

(4) Evidence in favor of the hydrate theory of ionization is afforded by a consideration of the mobilities of the different ions in aqueous solutions. In the following table of ionic mobilities.

Li	Na	K	Rb	Cs
33.44	43.55	64.67	67.6	68.2

the larger atoms yield the more mobile ions; the lithium ion (at weight seven) moves through the solution only half as rapidly as the rubidium ion (at weight eighty-five) or the cæsium ion (at weight 133). Such a result strongly supports the view that in aqueous solutions the ions are present in the form of complex hydrates.

(5) The mobility of the hydroxl ion is more than double as great as that of any other anion; while that of the hydrogen ion is nearly five times as great as that of any other kathion. The peculiar properties of these two ions are most readily explained by supposing that they are either anhydrous or are combined with a smaller proportion of water than any of the other ions. Confirmation of this view is afforded by at least two independent considerations:

(*i*) The affinity of water molecules for the ions H and OH must be relatively slight, since otherwise liquid water, like fused salt or caustic soda, would be a good electrolyte.

(*ii*) Whereas nearly all sodium and potassium salts are good conductors, the acids from which they are derived are often exceedingly poor conductors.

(6) Independent evidence in favor of the hydrate theory of ionization is to be found in a consideration of the freezing points of dilute aqueous solutions. At extreme dilutions the molecular depression of the freezing point reached a maximum value corresponding very closely with that required by the theory of electrolytic dissociation. In less dilute solutions, however, values are obtained which can not be accounted for in terms of this theory as originally propounded, but which are explicable if, as the hydrate-theory assumes, part of the solvent is removed as far as freezing point lowering is concerned.

(7) The theory of electrolytic dissociation owes much of its acceptability to the readiness with which it lends itself to exact mathematical treatment. The whole theory can indeed be summed up in the well-known equation

$$K = m\ a\ (u + v).$$

The essential constants of the hydrate theory are, however, quite as simple as those of Arrhenius's theory. For any given solution the chief constants are :(1) the total hydration H of the solution, which expresses the total number of molecules of water present per molecule of salt. (2) The coefficient of combination B, which expresses the fraction of the total quantity of water that is actually combined with the salt to form hydrates. (3) The product of these two quantities will give the average composition of the hydrates in solution; this may be termed the "molecular hydration" of the solution and may be represented by the symbol h. Thus $h = B\ H$ may be regarded as the fundamental equation of the hydrate theory.

Jones and Getman and Biltz have attempted to determine the molecular hydration of dissolved salts. Assuming that the abnormally great molecular depressions of the freezing point of salt solutions of moderate concentration were due to a combination of solvent and solute, Jones and Getman were able to compute the amount of solvent water remaining in the solution by comparing the observed molecular depression with that calculated from the coefficient of ionization of the solution.

The author, after correcting the figures —in which two serious flaws were made— calculated by Jones and Getman, shows that the corrected values point to a regular increase of molecular hydration as the dilution increases, and are, therefore, in accord with the view that ionization involves an increase, and not a decrease, in the hydration of the solute.

(8) The theory may easily be extended to non-aqueous electrolytes in which ionization may again be attributed to the superior combining power of the ions as compared with the molecules of the dissolved salt.

(9) In the case of autolytic salts, which became conductors when fused, it is known that polymerization is an essential characteristic of these, hence it is only necessary to suppose that the complex molecules of these are associated with the ions. Evidence of the formation of complex ions has recently been obtained in the case of fused salts by Lorenz and Fausti, who have shown that, in fused mixtures of lead chloride with sodium and potassium chlorides, the transport values prove that the lead is present in the form of a complex anion which travels in the opposite direction to the current. Their experiments afford direct evidence of the

presence in the fused salt of positive and negative ionic complexes.

Conduction in mixtures of solid oxides, such as the Nernst filament, is doubtless electrolytic in character. Like glass, this filament has the composition of an electrolyte, but behaves as an insulator until the temperature has been raised sufficiently to permit ionic migration to take place. Temperature-conductivity curves for filaments of very various compositions have been plotted by Reynolds, and are very similar in form to those for glass, or for overcooled, concentrated, aqueous solutions of calcium chloride or sulphuric acid. An even more striking resemblance is to be seen between the family of curves given by Reynolds for the conductivity of mixtures of ZrO_2 and Y_2O_3 at 900 degrees, 1,000 degrees, 1,100 degrees, 1,200 degrees, and 1,300 degrees centigrade and the isothermal conductivity concentration curves for mixtures of sodium hydroxide and water at 0 degrees, eighteen degrees, fifty degrees, and 100 degrees centigrade. The appearance of the two series of curves is such as to warrant the conclusion that the mechanism of conduction is essentially the same in the two cases.

Mr. H. D. Law pointed out that molecular mobilities were often largely influenced by the undissociated molecules; an ion might wander more quickly through its own molecule than through another. He thought that the experimental evidence on which the hydration was based was as yet somewhat slender.

Dr. C. H. Desch hoped that Dr. Lowry would develop the theory on the mathematical side. The unsymmetrical pulls, due to electric attractions, on an atom in a solution might be sufficient to cause an interchange of ions, and so explain how conduction occurs in solutions.

Mr. W. R. Bousfield (communicated) showed that the experimental investigation of the relation between hydration and ionization could be approached along three conveying lines: firstly, on the assumption of a rectilinear relationship between freezing point depression and concentration; secondly, on the assumption that the amount of contraction per gramme of solute, in aqueous solutions, is a measure of the combination between solvent and solute; and thirdly, by a consideration of the variations of ionic sizes with temperature and concentration based on the application of Stokes's theorem on the movement of small sphere in a viscous fluid. The results of these three lines of investigation indicated the generalization, pointed to by Dr. Lowry, that the amount of combination of solvent with solute increased progressively and continuously with increasing dilution. With regard to the conductivity of water, he inclined to the opinion that the H and OH ions were not entirely anhydrous, but were combined with a smaller proportion of water than any of the other ions, and that the conductivity of water depended upon a volatile organic impurity.

Dr. F. G. Donnan (communicated) drew attention to the work of Werner, who first showed how it was possible to bridge over the gap between the "hydrate" and the "ionization" theories.

Mr. G. T. Beilby, referring to the author's views on solid conduction, said that recent observations of his seemed to prove that the impact of electrons (*e.g.*, β rays) was able to produce electrolysis—ionization—in solid crystals, such as calcspar.

International Electrical Exhibition.

From present indications the coming International Electrical Exhibition, to be held in the Mechanics' Building, Boston, Mass., July 15 to 22, will be the most important event of its kind on record. The manager, Chester I. Campbell, has already been notified that thirty-nine states will send delegates to the fifth annual convention of the National Association of Electrical Contractors, which will be held at the same time and place. A large and efficient reception committee will extend welcome and entertainment.

The entire building, comprising 83,000 square feet of floor space, will be occupied. The exhibition, it is expected, will cover the widest range possible of apparatus relating in any manner to electricity. It will include many of the latest achievements of electrical science. In addition to the great number of still exhibits, a large part of the apparatus will be in active operation.

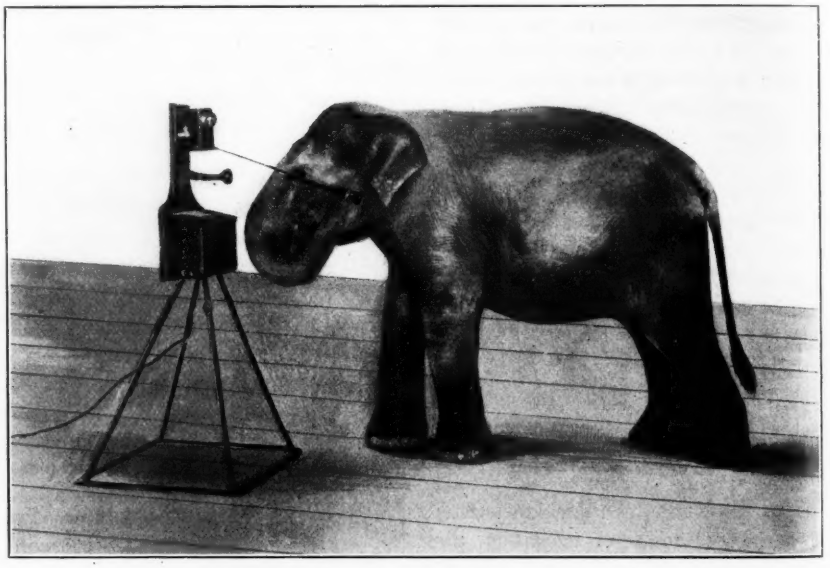
A Communicative Elephant.

The possible extent of the application of the telephone by its use in calling a dog which recognizes his master's voice has recently obtained an unexpected reenforcement at the New York Hippodrome, where one of the elephants gravely steps out from the herd where he has been performing various stunts with his associates, and walks up to a telephone, turns the crank, takes the receiver from the hook and holds it to his ear, only to hand it up again and petulantly sway his trunk because the line is busy.

In a moment, a second attempt again finds a busy line and the disappointment is evident by his stepping backward and vigorously slapping his trunk from side to side with considerable anger.

The third attempt obtains a satisfactory connection and the joyous squeals at the transmitter indicate that promises of sugar or other pleasant communications are received over the telephone.

The elephant is the only tool-using animal in that it uses branches of trees to brush off insects, and also will naturally pry with a beam in a manner indicating a comprehension of the principle of the lever.



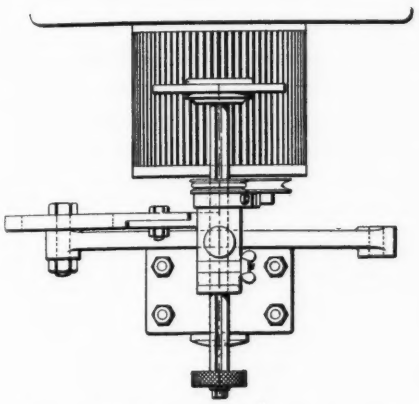
A Communicative Elephant.

The finder of a stray dog, telephoned to the owner fifteen miles away, by reason of the name on the collar, and the owner told the finder to hold the receiver down so that the dog could hear the call.

The dog capered in delight at hearing its master's voice, and then showed its own mental limitations in its evident resolve to rescue the master from the confinement of the receiver by craunching the fragile rubber shell with his teeth.

Electrical Patents.

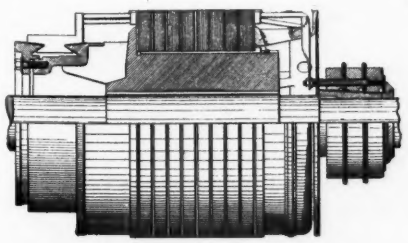
A machine for grinding commutators of dynamos or motors has been devised and patented by William H. Jordan, of Brooklyn, N. Y., and a three-fourths interest in this patent has been assigned to John F. Jordan, George A. Jordan, and Christopher C. Jordan, of the same place (789,917, May 16, 1905). The inventor's object is to produce a device for grinding the commutators of motors or dynamos



MACHINE FOR GRINDING COMMUTATORS.

when such become worn, without dismantling the dynamo or motor. It is also the object to produce a device which may be readily applied to dynamos or motors of different sizes and designs, also a device which may be accurately adjusted in the relation to the commutator. A grinding-disc is provided which is supported by an adjustable shaft. Means are employed for adjusting the shaft. Bearings are provided for the shaft and a support for the bearings. The bearings are adjusted in relation to the support by means of an eccentric, and means are also provided for adjusting the support in relation to the work. The eccentric is secured to the support by suitable means.

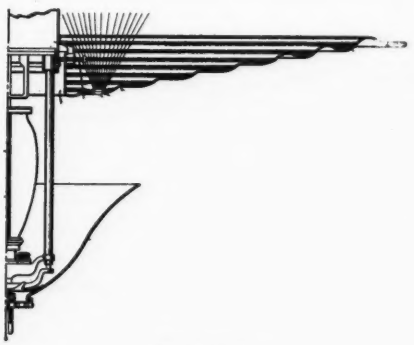
An alternating-current machine is the invention of Charles W. Johnson, of Nor-



ALTERNATING-CURRENT MACHINE.

wood, Ohio, and has been assigned by him by mesne assignments to the Bullock Electric Company, of Ohio (790,368, May 23, 1905). The invention relates to the rotating element of alternating-current machines, and particularly to connecting the windings to collector rings, and is applicable to the rotors of induction motors, to rotary converters, and to other machines in which the winding of the rotary element is connected to slip rings. The object of the invention is to provide a suitable support for the end connections of the windings and to produce a simple and compact arrangement of the connecting leads. By the present invention, the end connections of the windings are supported upon an end-head and the connections to the slip rings pass through the end-head toward the axis of the machine. In this manner a very direct connection is obtained, giving a simple construction, and the connections are enclosed and well protected by the end-head. In the embodiment of the invention, a core is provided and windings therefor. An end-head supports the end connections, the end-head having pockets covered by insulating material. Leads pass through a part only of the pockets. Blocks are fitted in the pockets through which the leads pass, and other blocks serve to guide the leads and collector rings to which the leads are connected.

Walter D'A. Ryan, of Lynn, Mass., has devised and patented an improvement in reflectors, which patent he has assigned to the General Electric Company, of New



REFLECTOR.

York (790,399, May 23, 1905). The object of the invention is the provision of improved means by which a proper distribution of the light emanating from a source can be obtained. The invention is more particularly intended to be used in conjunction with such a source of light as an arc lamp. The reflector has a circular outline and is formed with a ridge or corrugation on its reflecting surface which extends in spiral turns from the centre of the reflector outward, the amplitude of the corrugation increasing along the ridge from the centre outward. Dispersing lenses are located in apertures formed for the purpose in the reflector.

Nominations for Officers of the New York Electrical Society—New Members Elected.

At the meeting of the New York Electrical Society, held on May 24, the nominating committee made the following announcement:

For president, N. S. Barstow.

For vice-presidents: Albert F. Ganz, Louis B. Marks, N. S. Rugg, H. G. Stott, Putnam A. Bates, Max Loewenthal.

For secretary, George H. Gray.

For treasurer, H. A. Sinclair.

The following new members were elected:

Timothy Donovan, 243 East Thirty-eighth street, New York city; George W. Elliott, 114 Liberty street, New York city; Joseph J. Bigelow, 170 West Broadway, New York city; Clement F. Street, 836 Farragut street, Pittsburg, Pa.; F. H. Shepard, 11 Pine street, New York city; A. S. McAllister, 114 Liberty street, New York city; Thomas A. Nathans, 30 Gold street, New York city.

The Convention of the Street Railway Association of the State of New York.

The annual convention of the Street Railway Association of the State of New York will be held at the Fort William Henry Hotel, Lake George, N. Y., June 27 and 28. In addition to the question box, conducted by Mr. C. F. Fairchild, Jr., the following papers will be presented:

"Types of Interurban Cars," by J. N. Shannahan, Gloversville.

"Municipal Ownership," by W. J. Clark, Schenectady.

"Medical Examination of Employés," by Dr. F. H. Peck, Utica.

"Publicity," by J. H. White, Boston Elevated Railway.

The following committee has been appointed to have charge of the exhibition of the supply men: F. V. Green, Westinghouse Traction Brake Company; H. C. Evans, Lorain Steel Company; Henry N. Ransom, and B. H. Nostrand, Jr., Peekskill Lighting and Railway Company, Peekskill, N. Y., chairman.

Wireless Telegraphy Experiments at Purdue University.

Purdue University, located at Lafayette, Ind., is about to institute a series of experiments on the transmission of messages to railroad trains by means of wireless telegraphy. A number of railroads are in plain view for a long distance from the electrical engineering building. These roads include the Wabash, Big Four, and Monon. The various roads will place wireless telegraph instruments on a number of their trains and experiments will be conducted from the university. One experiment will be the placing of a receiver in the locomotive cab, enabling the engineer to take his orders from the train despatcher without bringing his train to a stop.

Reviews of Current Engineering and Scientific Literature.

The Discharge of Electrically Charged Electrolytic Surfaces by Light.

Lenard has shown that the discharge of negatively charged metallic surfaces by violet light, as discovered by Hertz, may be attributed to cathode rays at least, if the experiment is conducted in a vacuum, and the action of light on a surface surrounded by air is not essentially different. This led Lenard to say that the cathode rays given out from the illuminated surface are absorbed by the surrounding gas, and thus the discharge is dissipated. Recently Bose has shown that cathode rays are given off by electrolytic surfaces when contained in an exhausted tube if the vapor pressure of the electrolyte be sufficiently low. He conducted experiments on the following substances: the Nernst lamp glowers, concentrated sulphuric acid, concentrated phosphoric acid, a solution of sodium nitrate in water and concentrated solutions of the alkalies and calcium chloride. Herr C. Schaefer concluded from these experiments that charged electrolytic surfaces would show the same phenomena as metallic surfaces and would be discharged by ultra-violet light. To test his conclusion experimentally, he arranged an electrolyte in a glass tube, made contact at the bottom by means of mercury, and charged it negatively by means of a battery. An electroscope was connected to the electrolyte, and an arc lamp arranged so as to illuminate the surface of the electrolyte. By means of a quartz lens the violet rays were cut off or allowed to fall on the surface, as desired. The experiment showed that the light had no discharging effect. Electrolytes were then prepared and colored with different materials, still with only negative results. To explain this failure, the author compares our ideas of electrolytic and metallic conduction. In the latter, transport of electricity is accomplished by free negative electrons comparatively massless, and by positively charged atoms or ions. Electrolytic conduction is brought about by positive and negatively charged ions, that is to say, electrons associated with mass. The effect of ultra-violet light is to set free the electrons in a metal. As yet we know of no method of separating from an ion its electron and leaving a neutral atom, and hence there is no discharging effect of ultra-violet light on electrolytes. If a method of doing this were found, it is believed that ultra-violet light will show the same discharge action with charged electrolytic surfaces.—*Translated and abstracted from Physikalische Zeitschrift (Leipsic), May* 1.

Magnetic and Electric Properties of Various Kinds of Sheet Steel and Steel Castings.

A brief account is here given of a research carried out by Messrs. Gunnar Dillner and A. F. Enström, holders of Carnegie research scholarships, into the magnetic and electric properties of various kinds of steel. The researches were conducted at the testing institution of the Royal Technical University of Stockholm. Samples of commercial steel sheet and steel castings were obtained from ten Swedish iron works, and later a number of samples were prepared having specific chemical constitutions. The cast samples were accurately turned to standard size, and tested in the du Bois magnetic balance, the samples being turned spherically on the ends. The sheet samples were made of strips punched with the aid of a cutting machine specially constructed for the purpose. These strips were slightly ground to remove the greater part of the scale, and they were tested by a magnetometer. The electrical resistance was measured in the steel bars, but not in the strips, owing to the difficulty met in determining the area of the strips. It was found that an increase of carbon implies a corresponding increase in the coercive force, and also of the hysteresis energy loss. The increase of the coercive force and the hysteresis coefficient have been found to follow a straight line within the range of a carbon percentage of one-half per cent. A small amount of carbon is favorable in sheets used in armature cores and transformers. As regards the cast steel, there should be no inconvenience involved in the increase of the carbon percentage, so far as is shown by the present researches. With the very high percentage met with in the cast steel employed, values of the maximum induction and of the permeability at the induction usual in field poles can not be considered as quite satisfactory. On the other hand, the hysteresis properties of cast steel are comparatively unimportant. A high percentage of carbon produces an increase in the electrical resistance which is advantageous. An increase of silicon is accompanied by a noticeable increase of the coercive force and of the hysteresis energy loss, while the maximum induction does not seem to be influenced to any great extent. The hysteresis loss is thus increased by the presence of the silicon, a disadvantage outweighing the corresponding gain in electrical resistance. Any addition of silicon ought to be avoided in the case of sheet steel. It is of little importance in cast steel, since it does not noticeably affect the permeability, remanence and maximum induction, although increasing the resistance. The addition of aluminum noticeably reduces the hysteresis loss, at the same time increasing the electric resistance. An addition of aluminum, however, reduces the maximum induction and the permeability for ordinary saturation values. The general conclusion is that an addition of aluminum improves sheet material which is used for constructing dynamos. As regards cast steel, it is disadvantageous, since it affects the magnetic properties too much. When both aluminum and silicon are present, the influence of the former on the permeability and maximum induction seems to be neutralized by the addition of silicon. The results of the research are in agreement with Le Chatelier's theory that the electrical resistance is proportionate to the number of atoms present, and to Benediks's formula for calculating it. The cast-steel rods were examined before and after annealing. As a rule, the annealing improves the magnetic properties in general, more especially the hysteresis loss. No annealing tests were made on the sheet material, but samples were selected from the centre and from the borders of the plates, and compared. Samples from the edges have a greater maximum induction than those from the centre, while the coercive force and hysteresis loss of the centre samples are about ten per cent greater than that of the edge. The samples of Swedish soft steel sent in were produced by different methods. Comparing these samples, it appears that Bessemer steel has a lower magnetic quality than open-hearth steel; that steel prepared by the basic open-hearth process is preferable to that prepared by the acid open-hearth process, and that the former is scarcely inferior to Lancashire iron. It is thought that the poorer quality of the Bessemer material is due to the gases dissolved in the metal. In

general, basic steel does not contain such large quantities of silicon and manganese as acid steel, and at the same time it is possible to get a lower percentage of carbon in the first-mentioned metal. Microscopical researches on the samples show that a high percentage of silicon in steel causes the cementite to be transformed partly into graphite. In steel with a high content of aluminum, the carbon is expelled from the interior of the grains, and is accumulated at the edges of the grains in a sorbitic state.—*Abstracted from the Electrician (London), May 19.*

The Hydroelectric Installation of Trubigo, Lombardy, Italy

Some years ago the Societa Lombarda per Distribuzione di Energia Elettrica erected a large hydroelectric station at Vizzola on the Ticino river. The output of this station was 14,000 horse-power, but the demands upon the station grew so that the company was forced to increase the plant to 19,000 horse-power. In spite of this increase it has been found necessary to provide for still greater demands, so that the company has built a new power station at Trubigo. This has been completed, and operates in parallel with the older plant. It is here described by Signor Enrico Bignami. Like the first plant, the new installation is operated by a bypass from the river Ticino. The new canal is 5,590 metres long, and makes available a head of 8.2 metres, which, at the rate of flow permitted by the terms of the concession—this being sixty-two cubic metres per second—makes available a total of 6,800 horse-power, or about 5,400 horse-power at the turbine shafts. The water is controlled by means of a dam and ten intake sluices. The power-station buildings are situated at the end of the canal on the left bank of the river. They consist of two parts, the first facing the upper canal, and in direct communication with the forebay formed at the end of the canal. This building contains the turbines, each of which is fixed at the bottom of a separate basin open to the sky. In the second building, which adjoins the first, is the electrical machinery. There is here one large room, forty metres long by ten metres wide and twelve metres high, and a number of smaller offices. As it is necessary to maintain a constant head of water in the spillway canal, the water from this canal being used for irrigation purposes and controlled by means of gates, three spillways have been provided, which bypass water around the turbine pits. These spillways are controlled by a gate operated automatically by an electrical device, itself controlled by slight variations of level in the spillway. The generating plant consists of five three-phase alternators directly coupled to the horizontal shafts of the turbines. They are rated at 1,500 horse-power and 1,320 kilowatts, 11,000 volts, fifty cycles per second. Four of these machines are normally in operation, one being reserved. Two exciter groups are provided, each consisting of a 100-horse-power generator driven by a horizontal turbine. From this station power is transmitted over three lines and distributed mostly in the area served as well from the Vizzola station. The greater portion of it is consumed in the Legnano district.—*Abstracted from the Electrical Review (London), May 19.*

Schmitt Accumulators.

The Schmitt accumulator, here described by M. T. Pausert, differs most from other storage batteries in the method of preparing the active material. A mixture of pulverized oxides of lead, sulphuric acid and glycerine is formed, which is distributed in layers about ten millimetres thick over discs of sheet iron. The layers thus prepared are then placed in a compression cylinder and subjected to a pressure of 700 kilogrammes per square centimetre. The plates of active material thus formed are dried. They are very dense, slightly porous, and are as hard as ordinary cement. These plates are crushed and sifted so as to give grains irregular in shape, but having an approximately constant weight. To form an electrode, the material thus prepared is packed tightly in boxes, the box forming the negative electrode being completely filled; that forming the positive electrode not being quite filled. The current is led in through strips of antimonious lead. The shape of the elements depends upon the service for which they are intended. For traction purposes a square box of some non-conducting material, such as hard rubber or celluloid, is used, the conductor lead being formed of two long lead strips, each bent longitudinally so as to form a right angle, with the apexes welded together to form an x. This terminal is then given a quarter twist at the centre. The active material is packed tightly around it. Circulation is secured by means of perforations in the lead terminal and in the containing-case. The stationary type of electrode is formed in a rectangular, but narrow, box. The terminal of this case consists of a number of parallel strips of lead running horizontally through the active material, and attached to a stout terminal at one end. The advantages claimed for this accumulator are the good conductivity secured, the freedom from buckling, and free circulation of the electrolyte. A cell consisting of seventeen positive and eighteen negative tubes, the positive tubes weighing altogether 4.76 kilogrammes, and the negative tubes 4.68 kilogrammes, is 17.8 centimetres long, 11.3 centimetres wide, and twenty-two centimetres high. The total weight is fourteen kilogrammes. This cell is rated at 300 ampere-hours for a ten-hour discharge, or 220 ampere-hours for a four-hour discharge.—*Translated and abstracted from La Revue Électrique (Paris), May 15.*

The Question of the Gas Turbine.

An answer to the question "why not a gas turbine" is here given by Professor Sidney E. Reeve. The author first shows why the steam turbine promises to displace the reciprocating engine, and then points out that the same conditions do not obtain in gas-engine practice. The prime problem of steam-engine design, from the days of James Watts, has been to reduce or prevent cylinder condensation. On the other hand, in a gas engine there is no condensation; and on account of the high temperature, we are forced to cool the cylinder rather than heat it. The steam turbine has made possible a desirable increase in rotative speed, but to employ high-temperature, high-pressure gases efficiently directly in a steam turbine will call for speeds far too great. Nevertheless, Professor Reeve believes that the development of a gas turbine is a desirable thing. As to the practicability of the gas turbine, two phases of the development must be considered. The author shows that the cycles commonly used in reciprocating gas engines can not be applied to the turbine. If the gases are admitted directly into the turbine, the temperature is too high. If expended simply in a nozzle the velocity is too great. To get around these difficulties the gases may be mixed with steam. Thus not only will the temperature be reduced, but the weight of the fluid will be increased, and hence the velocity of exit under any pressure decreased. This process would overcome not only the thermodynamic, but the mechanical difficulties. The conclusion is reached that the gas turbine is a machine immediately practicable both thermodynamically and mechanically, with the sole exception of the question of the best method of forcing the fuel and air into the generator.—*Abstracted from the Engineering Magazine (New York), June.*

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Fort Wayne Prepayment Wattmeters.

The reason for the failure of many prepayment wattmeter designs lies in the fact that the prepayment mechanism has required too great a torque for its operation and affected the light load registration of the meter. The Fort Wayne Electric Works, Fort Wayne, Ind., is now placing upon the market a prepayment wattmeter which requires such an extremely low torque for the operation of its prepayment mechanism that the smallest amount of energy which will cause the meter to run will operate the device perfectly.

The new prepayment mechanism is compact in form and neat in appearance. It has been applied to the popular type K induction integrating wattmeter which has met with such success in the past as

FIG. 1.—TYPE K, FORT WAYNE PREPAYMENT WATTMETER.

well as to the new "Wood" type W meter which has recently been described in these columns.

Fig. 1 is an outside view of the type K prepayment wattmeter, while Fig. 2 shows the same mechanism applied to the type W meter.

These meters are at present designed to operate with a dime and may be credited with two dollars' worth of energy at one time. The capacity of the money box is ten dollars. The Fort Wayne Electric Works will soon place upon the market, however, a meter whose operating coin will be the quarter, as considerable demand has already been made for such a meter. This meter may be credited with five dollars' worth of energy at one time and has a total capacity of twelve dollars in quarters.

Upon inserting a coin into the slot at the top of the meter the former acts as a key, locking the crediting device to the knob, so that one-half turn of the latter credits the coin upon the dial and deposits same in the money box. This operation is accomplished as follows:

Upon the further end of the crediting spindle is a pinion which engages an intermediate gear. This intermediate gear also engages the inside annular gear of the escapement mechanism. The coin acting as a key in rotating the above pinion causes the intermediate gear to roll about the pinion as an axis. This forces the numbered dial ahead under the tension of a flat-coiled spring. Thus power for the debiting operation is stored up in the spring. This operation of crediting may be repeated until the dial at the top of the meter shows twenty dimes credited.

After the coin has once been inserted and the knob turned, it is locked within the meter and can only be obtained by opening the money box. It is only by turning the knob one-half revolution that the consumer can obtain credit for his payment. After twenty dimes have been credited the slot is closed, preventing the insertion of another coin until a dime's worth of energy has been used.

The same operation that credits the first coin in the meter causes the circuit to be closed by means of a cam on the crediting drum. This cam operates a lever-arm which in turn engages the switch-bar and closes both circuits under the tension of a coiled spring. Fig. 3 shows the details of this switch.

After the amount of energy purchased has been used, and the drum, in debiting the coins, has returned to its initial position, the same cam releases the spring and causes the switch to open.

The only connection between the prepayment device and the recording train of the wattmeter is a pinion upon the former which engages a gear in the latter. In the operation of debiting every revolution of this pinion causes a stop to be removed from the gear train in the prepayment device by means of a cam mounted upon the pinion shaft. The gear train thus released is free to revolve. This

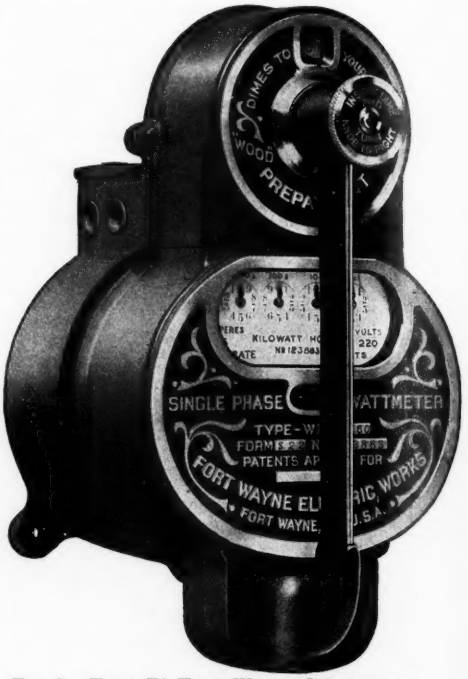


FIG. 2.—TYPE W, FORT WAYNE PREPAYMENT WATTMETER.

train consists of three gears and three pinions; one of the latter, however, simply operates a retarding fan (see Fig. 4).

In debiting, the intermediate gear in rolling about the centre stud under tension of the coiled spring carries with it the internal annular gear and causes the whole escapement motion of the prepayment device to operate, providing the latter be unlocked by one rotation of the small pinion as explained above.

The ratio of gears in the escapement train is fixed at such a value that when the dial has moved sufficiently to allow the next lower number to appear thereon, a pin upon the periphery of one of the large gears acts as a cam forcing a stop-lever into such a position that the latter immediately engages a pin on one of the lower gears and stops the whole mechanism. Thus it will be seen that for every revolution of the small pinion which engages the wattmeter recording train, one number is subtracted on the dial and the switch cam is brought just so much nearer

to the position in which it operates the switch and opens the circuit.

One of the valuable features of this prepayment meter is its ability to both credit money and debit energy at the same time. It is possible to accomplish this operation for the reason that the only connection between the crediting stud and the debiting escapement motion is an intermediate gear whose axis is not fixed.

In crediting, the intermediate gear rolls about one central pinion; in debiting, the annular gear together with the intermediate gear rolls about the central pinion. Thus when both operations take place at one time the pinion and the annular gear turn in opposite directions at equal speeds, causing the intermediate gear to simply revolve upon its own axis without changing the numbers on the dial in any way. Although the debiting device is usually locked during the crediting operation, it will be seen that the value of the meter is greatly increased by its ability to perform both operations simultaneously when such an occasion arises.

The money box of this meter has been designed with the idea of making it as nearly tamper proof as possible, for it is not possible to gain access to the lock without first breaking an auxiliary seal. When the lock is reached it is found to be of the concealed Yale type which can not be picked, and can be opened only

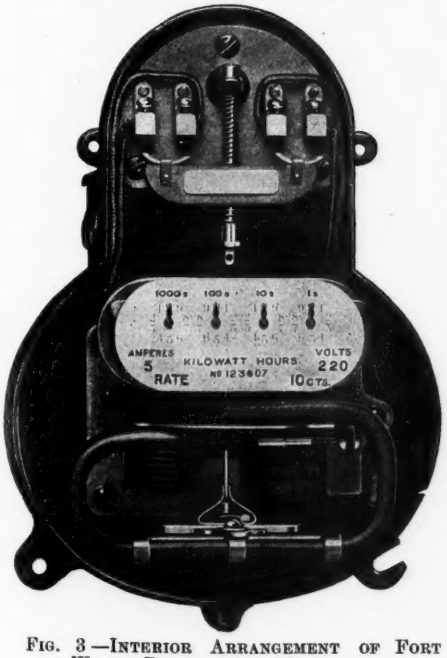


FIG. 3.—INTERIOR ARRANGEMENT OF FORT WAYNE PREPAYMENT WATTMETERS.

by one special key in the possession of employés. This operation of removing the box, however, can be accomplished without interfering with the meter in any way.

The flexibility of this meter will at once attract the interest of the central station manager. It can be readily adjusted for any rate up to twenty per cent per kilowatt-hour and its principle of combining the time switch with the integrating wattmeter will gain for itself

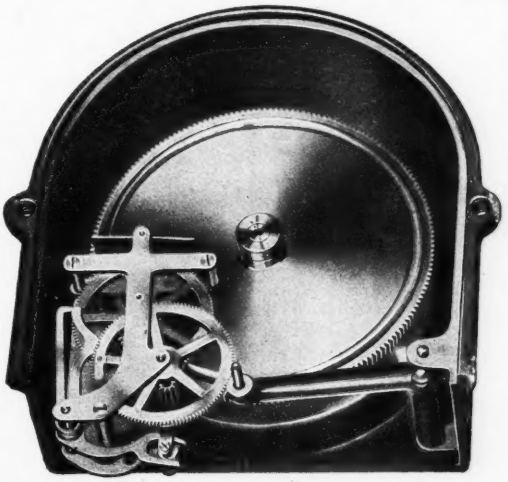


FIG. 4.—DEBITING APPARATUS FORT WAYNE PREPAYMENT WATTMETERS.

an entirely new field of service, especially in sign lighting.

In short, this meter will satisfy a long-felt want among a widely varying class of consumers. The central station will be protected by its use and the consumer will feel better satisfied. It is the ideal installation for the consumer using small amounts of power and in addition it will reduce the amount of bookkeeping and fault-finding to a minimum.

The booklet "Notes on Prepayment Wattmeters" recently published by the Fort Wayne Electric Works clearly sets forth the advantages of this meter, while bulletin No. 1063 and bulletin No. 1066 explain its operation more in detail. These publications will be forwarded upon application.

Orders for the Westinghouse Draft Gear.

The Westinghouse Air-Brake Company has just received orders from the Baltimore & Ohio Railroad system for the equipment of 10,000 of its cars with Westinghouse friction draft-gear apparatus. This will now make a total of 25,000 cars on this system equipped with the friction draft-gear device.

It is interesting to relate in this connection that the Pennsylvania system has now a total of 70,000 cars equipped with this same device.

One of the features of the tests shown the visiting members of the International Railway Congress when they were at East Pittsburg during the month of May was the efficacy of this apparatus to save wear and tear on rolling stock.

Richmond Electric Company's Induction Motors.

The Richmond Electric Company, Richmond, Va., is introducing an induction motor for which it claims a number of valuable features. In designing the motor the company has followed largely European practice, and has produced a motor which is stated to be extremely satisfactory in hard service and of high efficiency. By the use of special sheet steel of high quality, and extremely thin, the hysteresis loss in the motor stators has been reduced to a minimum. The heat losses of the stators are kept down by means of low-resistance windings.

The rotors are designed with heavy imbedded copper bars, and the secondary resistance is in the end rings, where ample ventilation prevents high temperatures. The general appearance of the motor is shown in Fig. 1, and the motor with rotor removed is shown in Fig. 2. The rotor itself is illustrated in Fig. 3.

The bearings are made of aluminum bronze, split, and are ring-oiled. Very large oil chambers provided with overflow and drain plug give ample oil storage capacity, and a system that will require the least possible attention. The heads are held on by four cap screws, and can be readily turned so as to suit the motor for floor, wall or ceiling use.

The motor is equipped with malleable iron skids, so that the skids can be safely lag-screwed or bolted to the ceiling tim-

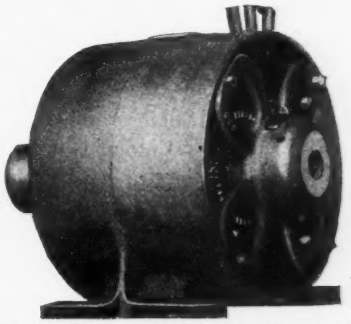


FIG. 1.—RICHMOND ELECTRIC COMPANY'S INDUCTION MOTORS.

bers, and the motor swung from the skids without danger, thus giving belt-tightening adjustment when used on the ceiling as well as on the floor. The shaft is extended on both ends so that, if desired, the motor can drive from either or both sides.

The smaller-sized motors are run at a speed of about 1,700 revolutions per minute; the larger sizes, at 1,150 revolutions. For slow speeds the maker recom-

mends a back-geared motor. For variable speeds a motor is provided which has two cone pulleys on either end of the shaft, thus giving four speeds with one belt.

The motors are built in standard sizes of one, two, three, five, seven and one-half, ten, fifteen and twenty horse-power,

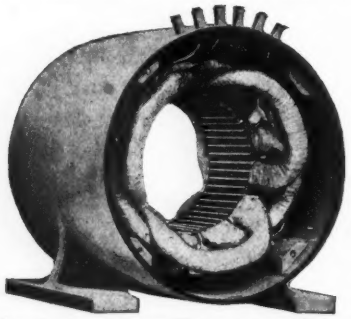


FIG. 2.—INDUCTION MOTOR WITH ROTOR REMOVED.

in all phases, cycles and voltages. The speed is not affected by the number of phases or the voltage. It is controlled by the cycles under which the motor is to operate. At sixty cycles the motors under ten horse-power run at about 1,700 revolutions per minute, and the larger

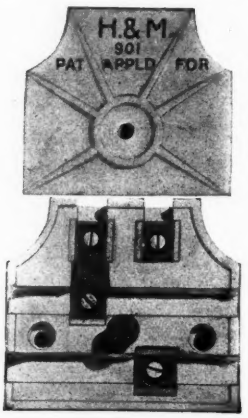
FIG. 3.—ROTOR OF RICHMOND INDUCTION MOTOR.

sizes at about 1,120. At forty cycles all sizes of motors run at about 1,120 revolutions per minute. At thirty cycles the smaller motors run at 1,720 revolutions per minute, and the larger sizes at 850.

A New Type of Moulding Branch Block.

The Elm City Engineering Company, New Haven, Ct., has brought out a new type of moulding branch block which is designed to overcome the disadvantages in making joints and taps in connection with wood-moulding work. In the ordinary method of wiring with moulding the main line of moulding can not be completed until all branch wires are spliced and soldered. With the use of the block shown in the accompanying illustration it is possible to complete the main line at once. It is usually necessary, when making branches or splices in the main line in moulding, to cut the grooves away in order to accommodate the increased size of wire. By the use of the block this is not necessary, and soldered joints are also done away with.

The wires connect under substantial screw heads, and all connecting parts are of sufficient strength and proportions to carry the current intended. It is impossible for contact parts to work loose, as they fit into the recessed parts of the porcelain. The porcelain cap covers the block, and is held in place by a knurled thumb-nut. The block, when in place, presents

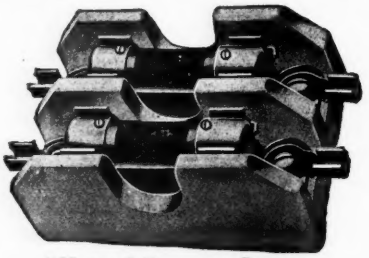


MOULDING BRANCH BLOCK.

a pleasing and, at the same time, a thoroughly safe way of making a branch. The company makes five styles, including two-wire main to double two-wire branch, and three-wire main and single and double two-wire branch. There are also three-wire mains to single and double three-wire branch.

Exhibit of the H. W. Johns-Manville Company.

The H. W. Johns-Manville Company is making an attractive exhibit at the Denver convention of the National Electric Light Association. The company is displaying a large board showing blocks, fuses and fittings of the "Noark" standard type. In addition there is a board consisting of blocks, fuses and fittings of



"NOARK" FUSE AND BLOCKS.

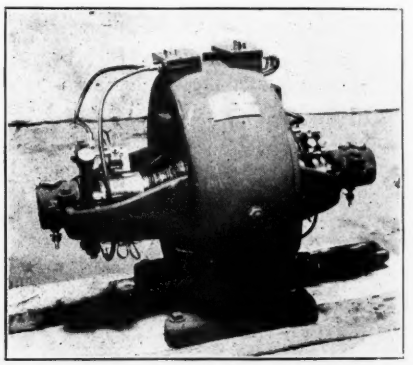
the National Electric Code standard, and a full line of the latest and most modern service and subway boxes.

The construction of the enclosed "Noark" fuses is such that there is no arcing even under conditions of a dead short-circuit. There is therefore no danger of the fuse setting fire to any of the surroundings or injuring the fittings to which it is connected. The fuse strip, which is enclosed in an outer tube, is made of a special grade of metal peculiarly adapted to the purpose. This is surrounded by a powder which protects it from currents of air and other disturbing influences. This powder, after the fuse has blown, immediately takes up the gases generated by the fusing of the metal, thus making the fuse safe under all conditions. A full line of the H. W. Johns-Manville strain insulators is also shown.

Mr. J. W. Perry, general manager of the electrical department, together with the Denver representatives, Hendrie & Bolthoff Manufacturing and Supply Company, is in charge of the exhibit.

A New Type of Dynamotor.

The dynamotor illustrated herewith has been placed on the market by the New England Motor Company, Lowell, Mass. This is a peculiarly handy machine for charging storage batteries or for such other purposes as may require the transformation of direct currents from one voltage to another. The machine is of the cradle type, the armature being



DYNAMOTOR FOR X-RAY OUTFIT.

mounted in a yoke or cradle entirely independent of the field frame. The armature may therefore be removed without disturbing the bearings. Owing to this peculiarity of construction the machine can be assembled for support whether on the floor, from the wall, or from the ceiling. The machine possesses the advantage that it is impossible for the bearings to get out of alignment when changing from one form of support to another.

The machine illustrated herewith was designed for the operation of a large X-ray outfit, and is intended to deliver thirty amperes at 110 volts on the low-pressure or secondary side, using a pressure of 220 volts on the primary.

The New England Motor Company manufactures a complete line of these dynamotors, and is finding a considerable demand for them for charging automobiles, running X-ray outfits, etc.

A Modern Hydraulic Elevator Plant.

The accompanying illustrations show portions of the power plant of the John Taylor Dry Goods Company, Kansas City, Mo., and show the three Worthington three-stage motor-driven turbine pumps operating the hydraulic elevator system in this company's store. The power plant of the store contains three generators, two of seventy-five kilowatts and one of 160 kilowatts, each direct-connected to a tandem-compound high-speed engine. These generating units supply power to motors for various services in the building. Power is distributed for electrically operating feed pumps, elevator pumps, a ventilating fan, an ice machine, circulating pumps, and other apparatus.

A notable and interesting feature of this plant is the battery of three high-pressure turbine pumps, shown in Fig. 1. Two machines, each of 300 gallons per minute capacity, are driven by forty-five-horse-power, 220-volt motors. The third pump has a capacity of 500 gallons per minute and is driven by a 220-volt motor of seventy horse-power. These machines maintain a pressure of 140 pounds in the system. Their motors are controlled by standard Cutler-Hammer automatic controlling apparatus, which is mounted on panels and assembled uniformly with the panels of the main switchboard. A portion of this board is shown in Fig. 2. The three pumps supply the water required for the complete hydraulic system, to which all the elevators of the store are connected.

The arrangement of piping for this system is unique and has proved to be the most highly satisfactory in service. There is one pressure main from the discharge openings of the pumps which runs through the whole building, past each of the elevator machines. This pressure main is connected to two compression tanks, one in each end of the building. These two tanks are set at the same level and carry their water lines at the same height. The connection for each elevator machine is taken from the main at a convenient point. There is a return main, paralleling the pressure main, into which each elevator machine discharges, and this return main is connected to each of two open, or "surge," tanks located near the compression tanks. These tanks are connected to the suctions of the pumps. With a suitable arrangement for removing entrained air from the suction line, the operation of the system is perfect.

During the hours of light load, one of the 300-gallon units operating at normal capacity will carry the service. During the hours of heavier service the 500-gallon pump will take care of the load, and during the hours of maximum load either of the 300-gallon machines, together with the 500-gallon one, will carry the load.

The floor space available for this installation was only 160 feet square. A compact outfit was necessary, as this installation is two floors below the ground in a subbasement in which there are many building columns and other obstructions, and where a very limited space was allowed to the engineers for the mechanical equipment. Noiseless operation also was essential in view of the location in a department store. The motor-driven turbine pump was chosen as the one which would best fulfil these conditions.

The nature of the turbine pump is such that a control device is not required except from considerations of economy. The pumps will automatically cease to discharge when the maximum pressure of the system is reached, and the current consumption of their motors will fall to that required to merely rotate the mass of water in the impeller chambers. When the pressure is reduced discharge begins and the current increases proportionately to the amount of pumping done. Consequently, the pumps will operate entirely automatically without any special controlling apparatus, which is greatly in their favor, but the addition of the Cutler-Hammer controlling mechanism is considered a step toward greater economy.

Attention is called to the details of the installation of these pumps. The discharge from each pump is conducted through a special enlarging cast-iron return bend and inverted nested check valve into a conduit under the floor, where it is connected to the pressure main of the hydraulic elevator system. The suction main is also laid in a carefully planned conduit, and the suction of each pump is provided with a separate gate valve, as shown in Fig. 1.

The foundations are of concrete, so formed as to provide ample space for the piping connections and suitable connections to the mains laid in the concrete conduits under the floors. These conduits are accessible through cover-lid sections, carrying on them the tile flooring uniform with the rest of the engine-room floor, and readily removable, uncovering all parts of the piping for inspection.

This plant was designed in all its details and its construction superintended by the engineering office of W. K. Palmer, 718 Dwight Building, Kansas City, Mo.

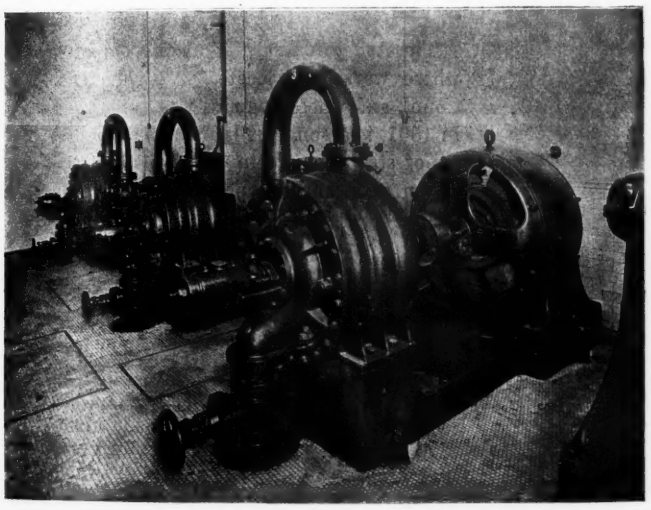


FIG. 1.—BATTERY OF HIGH-PRESSURE TURBINE PUMPS.

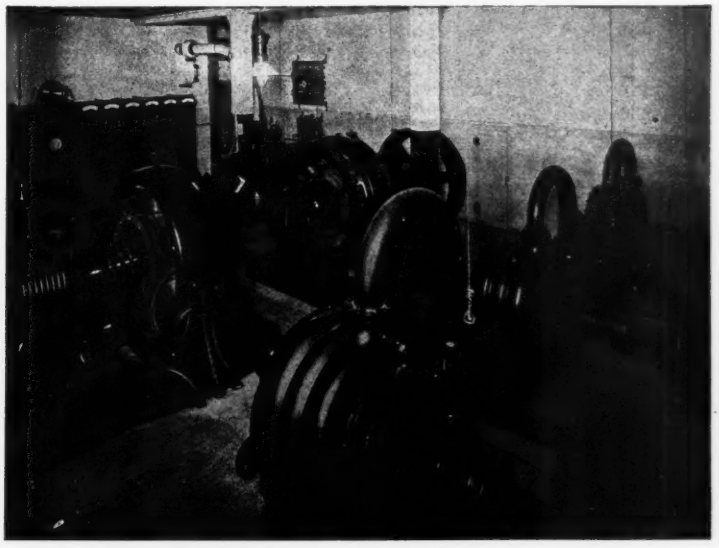


FIG. 2.—BATTERY OF HIGH-PRESSURE TURBINE PUMPS, SHOWING SWITCHBOARD.

Milo G. Kellogg's Present Plans and Work.

During the past year Milo G. Kellogg has gathered about him some of the foremost telephone engineers, inventors and patent experts, who were formerly in his employ in the Kellogg Switchboard and Supply Company. These men have been working industriously, developing several new lines of telephone apparatus. Mr. Kellogg's interest in the Kellogg Switchboard and Supply Company, as is well known, was sold out by his attorneys during a severe illness which caused him to retire temporarily from business and seek recuperation in the West. Mr. Kellogg has instituted proceedings to regain this interest. It is in order that there will be no deterioration in the Kellogg apparatus, and that he may thoroughly reinstate himself in the telephone manufacturing business, that this experimental and engineering corps has been established. The experimental shop has been in operation on the third floor of the Electrical Building, Jackson Boulevard, Chicago, Ill., for some time. The apparatus which Mr. Kellogg is developing, it is said, will show marked improvements in telephone apparatus construction. His efforts, up to the present time, have been directed especially to multiple switchboards, semi-automatic switchboard systems, full-automatic switchboard systems, and long-distance transmission apparatus.

EXPERIMENTAL AND ENGINEERING CORPS OF MILO G. KELLOGG.

Incorporation of Manning, Maxwell & Moore.

An important event in the machinery trade was the incorporation, on May 31, of Manning, Maxwell & Moore, Incorporated, composed of the well-known house of Manning, Maxwell & Moore and its allied manufacturing companies, The Shaw Electric Crane Company, The Ashcroft Manufacturing Company, The Consolidated Safety Valve Company, The Hayden & Derby Manufacturing Company, The Hancock Inspirator Company and the United Injector Company.

The corporation was formed under the laws of the state of New Jersey, having a paid-up capital of five million dollars. There is but one kind of stock, known as common, non-assessable.

The officers of the new concern are: Charles A. Moore, president; John N. Derby, vice-president; Martin Luscomb, vice-president; Stephen B. Aller, vice-president; Colby M. Chester, Jr., treasurer; J. H. Blue, assistant treasurer; Charles Arthur Moore, Jr., secretary, and Merle S. Clayton, assistant secretary.

There is to be a board of fifteen directors, among which are some prominent New York business men. The present directors are: Charles A. Moore, John N. Derby, Charles A. Moore, Jr., Colby M. Chester, Jr., J. Rogers Maxwell, Edmund C. Converse, Martin Luscomb, Stephen B. Aller, Alfred Brotherhood, Robert A. Bole, John G. Emery, Jr., James B. Brady, P. M. Brotherhood and A. J. Babcock.

Business will be carried on at the home office of Manning, Maxwell & Moore, at 85, 87 and 89 Liberty street, New York, and through its branch offices in Boston, Philadelphia, Chicago, Cleveland, Pittsburg and St. Louis.

The firm of Manning, Maxwell & Moore was established in 1881, composed of Henry S. Manning, Eugene L. Maxwell and Charles A. Moore. Mr. Maxwell died about ten years ago, and Mr. Moore recently purchased Mr. Manning's entire interest in the business.

The firm was remarkably successful from its inception. Of the several manufacturing companies involved in this consolidation, The Shaw Electric Crane Company, with works at Muskegon, Mich., is the manufacturer of the well-known Shaw electric traveling crane. The exhibit of this company received the grand prize at the Louisiana Purchase Exposition.

The Ashcroft Manufacturing Company, whose works are located at Bridgeport, Conn., and whose business was established in 1851, is among the largest manufacturers of steam gauges in the world. In addition to steam and pressure gauges, the company manufactures the celebrated Tabor steam engine indicator, the Edison recording gauge and an extensive line of pipe-fitters' tools. This company was awarded a grand prize at the St. Louis Exposition.

The Consolidated Safety Valve Company, whose works are also located in Bridgeport, makes the famous "Consolidated" safety valve, which is made under the original Richardson patents, and was the first successful "pop" safety valve ever produced.

The factory of the Hancock Inspirator Company is located in Boston, Mass. This business, established in 1876, consists of the manufacture of the Hancock inspirators for the feeding of locomotive, marine, stationary and portable boilers. Over 300,000 of these instruments are in daily use. This company also manufactures Hancock globe, angle, 60-degree and cross valves, and is making a complete line of locomotive trimmings.

The business of The Hayden & Derby Manufacturing Company was established in 1888, and has a factory in Boston devoted to the manufacture of "Metropolitan" injectors, of which there are over 150,000 in use. The company also makes the "H-D" ejectors and other jet apparatus.

The Consolidated Safety Valve Company, The Hancock Inspirator Company and The Hayden & Derby Manufacturing Company, all received gold medal awards for their exhibits at the St. Louis Exposition.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

MORTGAGE OF THE BUFFALO & NIAGARA FALLS ELECTRIC LIGHT AND POWER COMPANY—The Buffalo & Niagara Falls Electric Light and Power Company has given a mortgage to the Buffalo Loan, Trust and Safe Deposit Company for $2,500,000. The company contemplates extensive improvements, and has recently increased its capital stock.

LOCATION FOR POWER PLANT IN INDIANA—The Indiana Hydraulic Company announces that it will build a power plant at the mouth of Sugar creek, about twenty miles north of Terre Haute, Ind. The point on the creek at which the dam will be constructed is known as "Turkey Run," and it is figured that a minimum of 1,000 horse-power and a maximum of 2,000 horse-power can be obtained.

TRANSFER OF ELECTRIC COMPANY IN JAMAICA, WEST INDIES—It has been announced that the West India Electric Company, of Montreal, Quebec, has purchased the entire plant and business of the Jamaica Electric Light and Power Company, of Jamaica, West Indies. The price paid was about $80,000. The Canadian company now controls the entire electric traction and lighting interests in Kingston and Lower St. Andrew.

WORK COMMENCED ON LARGE POWER PLANT—Ground has been broken for the power plant of the Shasta Power Company, Shasta County, Cal. The Shasta Power Company has a franchise from the county, and will take water from the head of Hat creek at the base of Mount Lassen, and convey it twenty-five miles to the site of the power plant on Bear creek. The power plant will generate 3,000 horse-power, which will be transmitted at a voltage of 30,000. The company expects to complete the plant by the first of January.

NEW POWER PLANT IN MEXICO—The Toluca Electric Light and Power Company will develop a water-power concession on the Rio Verde river at Temascatepec. There is a total of about 8,000 horse-power available, but only 3,000 will be utilized at present. The chief engineer, R. J. M. Danley, has filed the final papers providing for the development of the water power, and work will be commenced at once. It is expected that the plant will be in operation by the end of the present year. The power will be distributed to the mining interests in the Temascatepec and Sultepec districts.

MAINE POWER PROJECT FINANCED—Farson, Leach & Company, of New York city, have financed the development of the Bodwell Water Power Company's property at Oldtown and Milford, Me. The company proposes to build a dam and power-house, and to generate from 6,000 to 8,000 horse-power, in addition to the present development. The company has contracted to deliver over 6,000 horse-power of the present development to various manufacturing companies nearby. The power company owns a large amount of land at Oldtown and Milford, which is suitable for factory sites.

LARGE POWER PLANT TO BE ERECTED IN CANADA—Arrangements have been made for a power plant at Upper Bonnington Falls, British Columbia. The plant, when completed, will generate 24,000 horse-power, and cost $1,000,000. This is in addition to the plant now established at the Lower Bonnington Falls, which generates 4,000 horse-power. The plant is intended to supply power to Grand Forks, Phœnix and Greenwood. William M. Doull is president of the company, and L. A. Campbell, general manager of the West Kootenay (British Columbia) Light and Power Company, has charge of the arrangements.

MERGER OF TROLLEY CAR MANUFACTURING COMPANIES—Plans are under way whereby the companies engaged in the manufacture of steel railway cars throughout the country will be merged. Options have been secured on the Laconia Car Company, of Boston, Mass., and Laconia, N. H.; the J. G. Brill Company, Philadelphia, Pa., Elizabeth, N. J., St. Louis, Mo., and Cleveland, Ohio; the St. Louis Car Company, St. Louis, Mo.; the Mason Manufacturing Company, Springfield, Mass.; the Bradley Car Company, Worcester, Mass., and the Jewett Car Company, Newark, Ohio. The plans contemplate a single corporation with a capital of $50,000,000.

ELECTRIFICATION OF THE PHILADELPHIA & READING RAILWAY—It is announced that the Philadelphia & Reading Railway will operate its local suburban trains by electricity for a distance of ten miles out of Philadelphia. This is to be done in connection with the elevation of the railroad company's tracks in Ninth street. When the tracks are elevated and the trains operated electrically, it is planned to build stations at short distances throughout the city, and give a service similar to that maintained on the elevated lines in New York. Vice-President Voorhees stated that the plans did not contemplate the operation of the fast express trains by any other motive power than steam, but that all suburban trains would be operated electrically.

SALE OF NEW YORK & LONG ISLAND TRACTION COMPANY—The New York & Long Island Traction Company has sold its entire plant to Sanderson & Porter, electric railroad contractors, of New York city. The New York & Long Island Traction Company controls thirty-four miles of line, extending from Mineola to Hempstead and from Hempstead to Jamaica. Another line runs from Hempstead to Freeport and from Freeport to Rockville Centre, Valley Stream and South Jamaica to the Brooklyn line. The capital stock is $1,000,000, and its bonded indebtedness is $500,000. The first section of the road was opened in 1902, and the last extension was completed about six weeks ago. The price paid for the road by the new owners is $1,450,000.

DEVELOPMENT OF THE TENNESSEE RIVER TO SUPPLY ELECTRIC POWER—Arrangements have been completed to incorporate the Chattanooga-Tennessee River Electric Power Company, under the laws of the state of Tennessee, with a capital of $3,000,000. The company proposes to begin work within sixty days upon the erection of a power plant at the "suck" on the Tennessee river, twelve miles from Chattanooga. The plant will have a minimum capacity of 30,000 horse-power, making the plant second only to Niagara. The total amount of current which can be produced is estimated at about 60,000 horse-power. The cost of the dam and lock will be $1,180,000, and the cost of the gates for the lock, $150,000. The power plant is to be located on the east side of the river. The building will be 60 by 300 feet, and fifty-seven feet high. The power will be furnished by thirty-six turbines. Applications have already been made by factories in Chattanooga for the use of 4,000 horse-power when the plant is completed. The financial arrangements have been in charge of C. E. James and J. C. Guild, and the construction work will probably be under the charge of Major Newcomber, the government engineer. It is proposed to have the plant in operation within twelve months.

AUTOMOBILE NOTES.

THE HAROLD E. THOMAS CHALLENGE CUP—The Automobile Club of America has accepted the custody of a challenge cup, donated by Harold E. Thomas, to be competed for by the Automobile Club of America and the Chicago Automobile Club, and which is to be the private property of the club winning three successive races for it.

A DANGEROUS CORNER IN SCARBOROUGH-ON-THE-HUDSON—A prominent citizen of Scarborough-on-the-Hudson has appealed to the Automobile Club of America to call the attention of all automobilists to the exceedingly dangerous corner on Broadway (Albany Post Road) in Scarborough, in front of the Presbyterian Church, where the Briarcliff road and the road to the Scarborough Railroad station intersect Broadway. The approach to Broadway is masked on the one hand by a high brick wall, and the road is down-grade, and on the other hand by a sharp curve. Several serious accidents have narrowly been averted at this point. Automobilists are requested to observe the warning signs upon their approach to this point.

ELECTRIC RAILWAYS.

NEW MARTINSVILLE, W. VA.—At a special election a franchise was granted to the Wetzel & Tayler Street Railway Company.

EVANSVILLE, IND.—A preliminary survey for the proposed Evansville & Mount Vernon Traction line will be made immediately. At Mount Vernon it is said that the road will be in operation between the two points in twelve months.

LOS ANGELES, CAL.—The $25,000 to be placed at the disposal of the Huntington Electric Railway Company has been subscribed. The corporation is under contract to begin extending its line to Sierra Madre within thirty days after the sum is ready.

PITTSBURG, PA.—The Shenango Traction Company is seeking a right of way through Sharpsville, Pa. The franchise is limited to seventy years. The company agrees to pay a cash bonus of $1,000 and three per cent of the gross receipts after eight years.

GREENSBURG, PA.—The council of Mount Pleasant has granted a franchise to the Uniontown & Monongahela Electric Railway Company, a constituent concern of the West Penn Railways Company. It is stated that a new line to Greensburg, connecting Hecla and Youngwood, will be built.

KANSAS CITY, MO.—The Metropolitan car barn and power plant building at Eighteenth and Olive streets is to be remodeled at a cost of $20,000. The car storage capacity of the building will be increased about twenty-five per cent. An automatic sprinkling system for protection against fire may be installed.

MONROE, LA.—At a meeting of the city council the contract for the construction and equipment of the proposed electric street railway was formally awarded to the Western Electrical Construction Company, of St. Louis, for the sum of $100,000. The work is to commence at once and be completed within six months.

JACKSON, MICH.—The council of the village of Howell has granted a franchise through the streets of the village to James and Charles Van Keuren and others for an electric line from Lansing to Detroit. The village of Brighton has also granted a franchise to the same men. The franchise calls for beginning work in eight months.

SYRACUSE, N. Y.—The Syracuse Rapid Transit Company is about to purchase eighteen new cars at a cost of about $5,000 each. The cars are to be ordered at once, and must be delivered by October 1. The company will spend between $180,000 and $200,000 in improvements this summer. These improvements include the extension and double-tracking of a number of lines.

COLUMBUS, OHIO—The Columbus, Johnstown & New Albany Railway Company has given a mortgage to the Columbus Savings Bank and Trust Company for $450,000. The company intends paying off indebtedness and completing the line. The mortgage is to secure twenty-year gold bonds. At the same time the company canceled a $200,000 mortgage held by the Cleveland Trust Company.

NORRISTOWN, PA.—The Lansdale & Norristown trolley line, including all the property, buildings, terminal facilities and property, steam and power plant, engines, boilers, dynamos, generators, cars, ties, motors, power and car houses, overhead construction, branches, switches, rights of way, franchises and all other property real and personal, was sold at public auction on May 25 to General W. E. Doster, counsel for the Lehigh Valley National Bank, of Bethlehem, for $150,000.

WATERLOO, IOWA—The Greenville & Newnan Railway Company, with headquarters at Savannah, has been granted a charter. The company proposes to build a line of railway through Coweta and Meriwether counties, extending from Greenville, in the last-named county, to Newnan, in Coweta County, the line to be approximately thirty miles in length. The incorporators are J. F. Hanson and S. R. Jacques, of Macon; H. C. Cunningham, T. M. Cunningham, Jr., T. S. Moise, W. A. Winburn, Alexander R. Lawton, H. W. Johnson, J. T. Johnson and H. M. Steele, of Chatham County.

ROCHESTER, N. Y.—Offices have been established in Rochester by the Rochester & Southern Electric Company, which has yet to be incorporated, and which has been formed for the purpose of building an electric railway between Rochester and Elmira, with several branch lines. A company to be known as the Rochester & Southern Construction Company is to be incorporated with a capital of $100,000 to build the road, which is to be 120 miles long, and for which ninety per cent of the necessary consents for right of way are said to have been obtained. The power-house will probably be placed at Wayland.

OBITUARY NOTICE.

MR. EDWARD A. LESLIE, general manager of the Kings County Electric Light and Power Company, died on Monday, June 5, at his home, 262 Hancock street, Brooklyn, N. Y. Mr. Leslie suffered from pneumonia and pleurisy, and made a brave struggle against this complication, aided by every human agency possible. He was a man remarkable in many ways, and his loss will be keenly felt, not alone by his family and business associates, but he will be mourned by a host of friends and acquaintances who held him in high esteem. Mr. Leslie was born in Harrisburg, Pa., in 1849. He entered work in the telegraph service as messenger boy for the Illinois & Mississippi Telegraph Company at Freeport, Ill. Acquiring the art of telegraphy he was made manager of the office at Lena, Ill., and like most of the operators of that period, was used to supply vacancies in various places, until he finally found the way to New York city and entered the employ of the Western Union Telegraph Company. There he became manager of the cable department, the service of which he conducted with acknowledged fidelity and ability. In 1882 Mr. Leslie was appointed superintendent of the Mutual Union Telegraph Company, with headquarters at Washington, D. C., and in the year following accepted the appointment as assistant general superintendent of the Postal Telegraph Company. In 1884 he received the appointment of superintendent of the National Telegraph Company, which was a part of the Baltimore & Ohio system, and at the same time he was appointed superintendent of the eastern division of the Baltimore & Ohio Company, comprising the eastern states and portions of New York, New Jersey, Pennsylvania and Delaware. On October 1, 1885, in token of his ability and devotion, Mr. Leslie was appointed general superintendent of the eastern division with headquarters in New York. After a short period with a storage battery company he entered the employ of the Consolidated Telegraph and Electrical Subway Company, and in 1888 was made manager of the Manhattan Electric Light Company, afterwards consolidated with the Edison Electric Company, remaining with them until 1901, when he became the general manager of the Kings County Electric Light and Power Company, on Pearl street, Brooklyn. In that position he showed remarkable executive ability from the first, and formed friendships which have been strong and lasting. Mr. Leslie was a valued member of the Crescent Athletic, the Hamilton and the Brooklyn Whist clubs, in the latter of which he was vice-president. He was also a member of Grant Post, G. A. R., having entered the army as a drummer boy of sixteen years, at the beginning of the Civil War. He participated in the siege of Mobile in 1865, as a member of Company E of the Forty-sixth Regiment of Illinois Infantry Volunteers. He was also a popular member of the Masonic fraternity and belonged to Anglo-Saxon Lodge No. 137, F. and A. M., and to Kismet Temple, A. A. O. N. M. S. He leaves a widow who was a Miss M. E. Morley, and two children, Edward, Jr., and Miss Florence M. Leslie.

Photo by Dampf.
MR. E. A. LESLIE.

ELECTRIC LIGHTING.

WHITTIER, CAL.—The Edison Electric Company will double the capacity of its plant.

LEWISTOWN, MONT.—It is announced that John L. Bright will build a new electric light plant at Livingston.

JANESVILLE, WIS.—The Janesville Electric Company has been awarded a five-year contract for lighting the city.

TALLAPOOSA, GA.—Messrs. Gelder & Black have been granted a fifteen-year franchise to erect an electric light plant.

LOGAN, UTAH—The city will install a second unit at the municipal lighting plant. Work is to be completed by September 1.

PADUCAH, KY.—The Paducah Gas and Electric Company has been sold to James C. Utterback. The price paid is stated to be $135,000.

TRUCKEE, CAL.—The plant of the Truckee Electric Light and Power Company was totally destroyed by fire on May 29. The loss is about $40,000.

JOHNSON, VT.—Johnson has voted to secure the Ithiel falls, and to equip them so as to provide electric power. The estimated expense is $12,000.

GREENVILLE, MISS.—The Delta Electric Light, Power and Manufacturing Company has assumed control of the Greenville Light and Car Company.

FREDERICKSBURG, VA.—The city has voted not to sell the municipal electric light plant and franchise. The proposition was defeated by a majority of 314.

POTSDAM, N. Y.—The village trustees will offer for sale $40,000 worth of bonds. The proceeds are to be used to establish and maintain an electric light plant.

DETROIT, MICH.—The village waterworks and electric light plant at Trenton were destroyed by fire on May 27. The loss is $30,000, partially covered by insurance.

HOUSTON, TEX.—The electric light plant at Houston Heights will be renovated and put in operation by O. M. Carter. A quantity of new machinery will be added to the equipment.

PRAIRIE GROVE, ARK.—An electric light plant is soon to be established at Prairie Grove, and the streets are to be lighted with electricity. Clem Cummings has the matter in charge.

MORGANFIELD, KY.—T. W. Gilbert, of Chicago, has purchased the electric light plant for $6,000. The new owner proposes to install a 3,000-light generator, and a 200-horse-power engine.

CLARKSBORO, N. J.—It is proposed to install an electric plant to light the towns of Jefferson, Mount Royde, Clarksboro and Mickleton. A mill at Boody's pond will be converted for the station.

NEW CASTLE, COL.—The Henry Electrical Corporation, of Denver, has purchased the Peter Kinney electric light plant at New Castle, and will remodel it. New machinery will be installed.

LEBANON, N. H.—The Lebanon Electric Light Company has purchased the Chancellor water privilege on the Mascoma river. There is a twenty-two-foot head and about 200 horse-power is available.

WALLA WALLA, WASH.—The Northwestern Gas and Electric Company has secured the franchise for a street railway system from E. S. Isaacs. Construction will begin as soon as the material can be obtained.

LAWRENCE, KAN.—The Lawrence Electric Light Company has been reorganized, with Irving Hill as president and R. C. Johnston as secretary and manager. The company proposes to purchase new engines and dynamos and to enlarge the plant to three times its present capacity.

STAMFORD, VT.—The Stamford Heat and Power Company has organized with the following directors: John Tudor and Charles D. Houghton, of Stamford; C. H. Cutting, H. T. Cady, E. A. Richardson, J. D. Hunter and F. S. Richardson, of North Adams, Mass. The officers are: president, J. D. Hunter; vice-president, H. T. Cady; clerk, C. D. Houghton; treasurer, F. S. Richardson.

TELEPHONE AND TELEGRAPH.

HAMMONTON, N. J.—Plans are under way for the installation of a local telephone system at Hammonton.

ASHLAND, OHIO—The Bell Telephone Company, of Wellington, has built a line from Pleasant Home to Wooster.

BALTIMORE, MD.—The Marydel & Templeville Telephone Company has been incorporated with H. S. Daily as president.

CLYDE, N. Y.—The Empire State Telegraph and Telephone Company has begun the enlargement of its Clyde exchange.

WALLACE, IDA.—The Rocky Mountain Bell Telephone Company will make extensive improvements to its system in Wallace.

BESSEMER, ALA.—The Southern Telephone Company will construct two additional trunk lines between Bessemer and Birmingham.

PENN YAN, N. Y.—The Seneca-Gorham Telephone Company is being extended to Potter Center and other points throughout that locality.

BLOOMINGTON, MINN.—The Market Gardeners' Telephone system, of Bloomington, has been sold to the Fisher system, of Shakopee.

MIDDLETOWN, N. Y.—The Highland Telephone Company has secured a right of way through the village of Cornwall, and will extend its line at once.

WEST CHESTER, PA.—The Delaware & Atlantic Telephone Company is constructing a new line from Berwyn to Phœnixville *via* Diamond Rock, which is expected to facilitate increasing business in that direction.

HUNTSVILLE, ALA.—A new telephone system joining the villages northwest of Huntsville as far out as Kelly Station has been connected with the Huntsville telephone exchange. The new system serves a large population.

PLAIN CITY, UTAH—The Rocky Mountain Bell Telephone Company is putting in a new telephone system, making Plain City the central station of the northwestern part of Weber County. West Weber, Warren, Poplar and Far West will centralize at this point.

SOUTH BETHLEHEM, PA.—The Passer Rural Telephone Company organized recently with the following officers: president, W. B. Price; secretary and treasurer, Jacob A. Appel. The directors are E. P. Frankenfield, Benjamin Hottle, A. R. Trumbower, Isben Gross, Jacob Steyer, Eugene Leith and Clarence Bigot. Connection will be made at Hellertown with the Pennsylvania Telephone Company.

TERRIL, IOWA—The Terril Co-Operative Telephone Company, composed of local citizens, has bought the telephone system heretofore operated by the Midland Telephone Company, of Milford. The officers of the local company are: president, D. A. Daniels; vice-president, T. J. Randolph; secretary, D. E. Neville; treasurer, W. C. Edmunds; directors, Martin Adson, David Woods, Ole Fingerson and G. W. Nefzger.

BALTIMORE, MD.—The contract for building the Chesapeake & Potomac Telephone Company's new central headquarters has been awarded to the Herbert A. Weeks Company, of New York. The new building will have a frontage of forty feet and a depth of 150 feet. Fireproof construction will be used throughout. The frame of the building will be of steel and the foundations of concrete. Though the building will be nine stories high, the construction will be such as to permit the erection of two additional floors.

CORNING, N. Y.—The organization of the Galeton & Hull Telephone Company has been perfected, the necessary poles and material purchased, and the contract let for building a first-class metallic circuit telephone line from Galeton to the Hammersley river by way of Corbett, Hull and Logue. The officers are: J. S. Hull, Conrad, president; W. D. Cool, Galeton, vice-president; H. H. Griswold, Galeton, secretary and treasurer. It is the company's purpose to establish toll offices at Corbett, Hull, Logue and on the Hammersley river, with connections to the various jobbing camps of the extensive lumber region.

NEW INCORPORATIONS.

OMAHA, NEB.—Rock & Conklin Telephone Company. $10,000.

MEREDITH, N. H.—Meredith Electric Light Company. $9,000.

DES MOINES, IOWA—Walker Telephone and Telegraph Company. $10,000.

MILWAUKEE, WIS.—Buckeye Ridge Cooperative Telephone Company. $1,500.

HARRISBURG, PA.—Wissahickon Electric Company, of Fort Washington. $10,000.

MANCHESTER, N. H.—Manchester Street Railway Company. Increased to $250,000.

SPRINGFIELD, ILL.—Springfield Light, Heat and Power Company. Increased to $325,000.

LINCOLN, NEB.—Union Telephone Company, of Pleasant Dale; $5,000. Falls City Telephone Company; $50,000.

AUSTIN, TEX.—The Anglin Light Company, of Groesbeck. $6,000. Incorporators: Z. Anglin, John Clairman and John W. Turner.

SPRINGFIELD, ILL.—Beuld Electric Light and Power Company, of Hillsboro, $10,000. Incorporators: James A. Davis, H. E. Haag, J. R. Caudry.

LINCOLN, NEB.—Sherman County Telephone Company. To build, own and operate telephone lines in Sherman and surrounding counties. $50,000.

WARREN, OHIO—Carrollton Electric Company. $20,000. Incorporators: U. C. DeFord, J. C. Ferrall, W. O. DeFord, George J. Butler and T. J. Saltsman.

MIDDLETOWN, N. Y.—The Middletown Telephone Company, Middletown. $10,000. Directors: Edwin Fancher, J. B. Hulett, M. C. Conner, Middletown.

UTICA, N. Y.—Central New York Power Company. To sell gas and electricity in all parts of the state, except in Greater New York and Long Island. $1,000,000.

MINNEAPOLIS, MINN.—Hughes Electric Company. $100,000. Incorporators: Alexander H. Hughes, of Minneapolis; E. A. Hughes and W. V. Hughes, of Bismarck, N. D.

NASHVILLE, TENN.—Central Telephone Company, Fentress County. $10,000. Incorporators: O. C. Conatser, W. R. Case, W. L. Wright, C. O. Wright and L. A. Sole.

ALBANY, N. Y.—New York & Lake Erie Power and Transmission Company, of Erie County. $100,000. Directors: J. F. Aldrich, G. A. Ricker and C. F. Powell, of Buffalo.

WHITE PLAINS, N. Y.—Homans Light, Heat and Power Company. $250,000. Directors for the first year: Robert B. Marten, William P. Homans and Martin Swatts, all of Manhattan.

JEFFERSON CITY, MO.—Bogard & Bingham Telephone Company, of St. Louis. $2,000. Incorporators: William Tomlin, J. J. Tomlin, Thomas Knott, James H. Sheehan, B. J. Hurt, W. C. Auston and others.

DENVER, COL.—Republican Mountain & Gray's Peak Railway Company. $100,000. Incorporators: C. H. Green, W. N. W. Blayney, P. B. Tolles, J. A. Curran, F. I. Smith, C. K. Wolfe, Arnold Barnettler, Denver.

ALBANY, N. Y.—Rensselaer Heat, Light and Power Company. To furnish gas and electricity. $5,000. Directors: Edward J. McKenna and Lewis E. Griffith, of Troy, and Edmund L. Worden, of Hoosick Falls.

ST. PAUL, MINN.—Freeborn County Rural Telephone Company, of Glenville. $10,000. Incorporators: A. W. Trow, Martin Moe, S. P. Nelson, A. S. Budlong, N. P. Nelson, W. S. Palmer, Walter Knutson and Fred Will.

COLUMBUS, OHIO—The Ohio Traction Company, of Cincinnati. To lease, own and operate street and interurban roads in and between Cincinnati and Hamilton. $20,000,000. Incorporators: W. Kesley Schoepf, W. S. Rowe, W. C. Proctor, Briggs S. Cunningham and W. T. Irvin.

MALONE, N. Y.—Adirondack Home Telephone Company. To operate in Franklin, Clinton, St. Lawrence, Jefferson, Lewis and Essex counties. $150,000. Directors: Howard Hendrickson, W. A. Hendrickson, H. M. Keys, F. E. Griffin, W. B. Harris, H. J. Deikman and C. J. Crummey, of Albany.

WHEELING, W. VA.—Interurban Construction Company. To build an electric line from Zanesville to Roseville, and thence to Crooksville; also to construct electric plants, telephone lines, etc. $400,000. Incorporators: W. A. Wilson, Albert G. Hallock, Charles W. Jefferson, Horace D. Kennedy, Alfred Caldwell.

ALBANY, N. Y.—The Freeport Gas and Electric Company. Organized to manufacture and supply gas for lighting, and electricity for light, heat and power in the cities, villages and towns of New York state. $1,000. Directors: Leo W. Wertheimer, Manhattan; Henry C. Miller, of Tarrytown, N. Y., and Louis A. Klipp, of Brooklyn.

ALBANY, N. Y.—Ne-Ah-Ga Telephone Company, of Sterling. Formed for the purpose of connecting various houses and business places in Sterling, running from Fair Haven to southwest Oswego in Oswego County. $1,500. Directors: John R. Ingersoll, William R. Andrews, Levi S. Fralick, William H. Williams, Alexander Johnson, John Farden and Frank McIntyre.

ST. PAUL, MINN.—Comfrey Rural Telephone Company, Comfrey; $25,000; officers: president, J. A. Prim; vice-president, L. P. Richardson; secretary, C. L. Lunkersmith; treasurer, Oscar Erickson. Sleepy Eye Telephone Company, Sleepy Eye; $15,000; officers: president, J. M. Olsen; vice-president, Charles P. Cutting; secretary, William Brust; treasurer, A. A. Larrabee.

ALBANY, N. Y.—Western Counties Transmission Company, of Buffalo; to supply electricity in various counties of the state for light, heat and power purposes; $2,000,000; directors: R. W. Pomeroy, J. G. Dudley, H. T. Ramsdell, H. G. Meadows, C. L. Gurney, R. W. Chapin and L. B. Hart, of Buffalo. International Power and Transmission Company, of Niagara Falls; to supply electricity for light, heat and power purposes; $2,000,000; directors: S. P. Franchot, J. S. Simmons, F. J. Brown, Clarence Tower, John F. Lynch and H. H. Findlay, of Niagara Falls. Lindenwald Light, Heat and Power Company, Chatham, Columbia County; to supply gas and electricity; $25,000; directors: A. B. Gardenier, S. W. Smith and M. P. H. Smith, of Chatham. Hoosick Falls Illuminating Company, Hoosick Falls, Rensselaer County; to supply gas and electricity; $150,000; directors: Roger Lewis, L. C. Tetard, Sherman Cox and R. W. Gifford, of New York, and G. D. Martin, of Greenwich, Ct. Blasdell Electric Company, Blasdell, Erie County; to supply electricity for light, heat and power; $50,000; directors: J. B. Wall, M. M. Wall and T. H. Wall, of Buffalo. The Cazenovia Electric Company, Cazenovia, Madison County; $30,000; directors: Henry Burden, 2d, and R. F. Hubbard, of Cazenovia, and R. S. Brewster, of New York.

ALBANY, N. Y.—General Transmission Company; $15,000,000; directors: James D. Ferris, Robert A. Teepell, Fred E. Pond, Byron L. Moore, of Buffalo, and Hugh Taylor, of East Aurora. Niagara & Eastern Power Transmission Company; $2,000,000; directors: Henry B. Bodine, J. Gilmour Drayton, of Niagara Falls, and Addison H. Hinman, of Buffalo. Buffalo & Montauk Company; $2,000,000; directors: Hugh Taylor, of East Aurora; Byron L. Moore, Anthony P. Harks, Fred E. Pond and James D. Ferris, of Buffalo. The Niagara Gorge Power Company, of Buffalo; $2,000,000; directors: J. T. Jones, J. A. Jones, R. E. Powers and H. P. Bissell, of Buffalo. Dutchess Gas and Electric Company, of Poughkeepsie; $25,000; directors: A. E. Seibert, James Cochrane, of Brooklyn, and W. R. Maloney, of Poughkeepsie. The Genessee County Electric Light, Power and Gas Company, Batavia; $100,000; directors: S. B. Storer, Syracuse; R. M. Walker, C. C. Bradley, Batavia. The Dexter Electric Light and Power Company, Dexter; to furnish light and power in various towns and villages in Jefferson County; $100,000; directors: Edward Hunter and Catherine J. Hunter, Dexter; Celestin C. Burns and George H. Burns, Watertown. The Albany, Susquehanna Valley & Binghamton Power Company, Schenevus; $75,000; incorporators: Melvin Baldwin, John Graney, Schenevus; George Brooks, Cooperstown. Pioneer Gas and Electric Company; $300,000; directors: William F. Carroll, G. Harris, F. V. Barnes, H. E. Martin and George Clinton, Jr., of Buffalo.

PERSONAL MENTION.

MR. FRANK P. FOSTER, superintendent of fire-alarms in Corning, N. Y., has resigned his position to become electrician at the Corning Glass Works.

MR. SAMUEL HASTINGS has been appointed local manager of the Wisconsin Bell Telephone Company at Green Bay. He will succeed Mr. Frank Carswell.

MR. ROBERT McF. DOBLE, consulting engineer of the Abner Doble Company, San Francisco, is in Mexico for the purpose of investigating several important hydro-electric long-distance power projects.

MR. CHAS. S. DAVIS, for the past six years master electrician of the Bureau of Construction and Repair, Charlestown Navy Yard, has joined the engineering staff of the Holtzer-Cabot Electric Company, Boston, Mass. Mr. Davis entered upon the duties of his new position on June 1.

MR. A. G. MILLER, who has been division superintendent of the Rocky Mountain Bell Telephone Company, with headquarters at Helena, Mont., has been appointed as the first superintendent of the Bell Telephone company's new North Idaho division. His headquarters will be at Cœur d'Alene. This appointment took effect June 1. Mr. Miller will be succeeded as superintendent of the Montana division by Mr. Harry L. Burdick, of Chicago.

MR. GEORGE GIBBS has been appointed chief engineer of electric traction of the Pennsylvania, New York & Long Island and the Pennsylvania, New Jersey & New York Railroad companies. Mr. Gibbs will have supervision of all the electrical work and electrical equipment of the Pennsylvania lines and in the tunnels from Newark, N. J., to Long Island City. He is a vice-president of Westinghouse, Church, Kerr & Company, and will also be appointed chief engineer of the Long Island Railroad Company.

MR. E. M. HERR has been elected first vice-president and chief executive under the president of the Westinghouse Electric and Manufacturing Company. Mr. Herr is widely known among railroad managers, and is skilled not only in the manufacture of railway apparatus, but is also conversant with railroad operations. Mr. Herr was locomotive superintendent of the Northern Pacific Railway for a number of years, and previous to this had many years' experience in various positions on important railways in the West. For the past seven years he has been vice-president and general manager of the Westinghouse Air Brake Company.

LEGAL NOTE.

GENERAL ELECTRIC COMPANY LITIGATION—A decree has been filed in the United States Circuit Court, District of Indiana, under date of May 1, in favor of the General Electric Company, complainant, and against the Kuhlman Electric Company, defendant, in the three-phase transformer case litigation. The proceedings involved patent No. 422,746, issued to Michael von Dolivo-Dobrowolsky. The Court has adjudged that Dobrowolsky was the first true and original inventor of the inventions and improvements described and claimed in these letters-patent. It is also adjudged that the General Electric Company is the lawful and exclusive owner of these letters-patent. The Court decrees that the defendant, the Kuhlman Electric Company, has infringed upon these letters-patent, and the claim thereof, and upon the exclusive rights of the complainant under the same. The recovery of damages to the complainant by reason of the infringement has been referred to Edward Daniels, Esq., as master. In the under-running trolley case, involving the Van Depoele reissue patent No. 11,872, a decision has been filed in the United States Circuit Court for the Western District of New York, on May 8, in favor of the Thomson-Houston Electric Company, complainant, *versus* the International Trolley Controller Company, defendant.

ELECTRICAL SECURITIES.

Of course, the paramount subject of discussion last week was the overwhelming defeat of the Russian fleet in the Korean straits. Added to this, however, was the passage of the franchise tax law. It is freely predicted in many quarters that the first-mentioned catastrophe will not have the quickening influence for peace that was hoped, and the effect of the latter, of course, can not at this time be estimated. Despite the apparent sluggishness of sales and continued low prices the business of the country holds good, and the hope is still strong that there will be no further retrogression in any department of industry.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JUNE 3.

New York:	*Closing.*
Brooklyn Rapid Transit	63¾
Consolidated Gas	187
General Electric	173¼
Interborough Rapid Transit	198¼
Kings County Electric	200
Manhattan Elevated	163½
Metropolitan Street Railway	118⅝
New York & New Jersey Telephone	168
Westinghouse Manufacturing Company	190

The Metropolitan Street Railway Company has declared the quarterly dividend of 1¾ per cent, payable July 15. Books close June 24 and reopen July 15.

The consolidated statement of earnings and expenses of the New York City Railway system (including all lines owned or controlled) for the nine months ended March 31, 1905, is as follows: gross, $13,490,318; expenses, $7,610,899; net, $5,879,419; other income, $900,080, making a total of $6,779,499; charges, $8,703,876, leaving a deficit of $1,924,377, as compared with a deficit of $642,158 for the same period of 1904.

Boston:	*Closing.*
American Telephone and Telegraph	139
Edison Electric Illuminating	246
Massachusetts Electric	58
New England Telephone	138
Western Telephone and Telegraph preferred	99

Trustees of the Massachusetts Electric Companies have voted to postpone action regarding the declaration of a dividend upon the preferred stock.

Philadelphia:	*Closing.*
Electric Company of America	11⅜
Electric Storage Battery common	76
Electric Storage Battery preferred	76
Philadelphia Electric	8⅛
Philadelphia Rapid Transit	27¼
United Gas Improvement	92¼

The general balance sheet of the Electric Company of America as of December 31, 1904, shows assets of $5,061,896 and liabilities of $4,289,674, leaving a surplus of $772,222.

Chicago:	*Closing.*
Chicago Telephone	134
Chicago Edison Light	160
Metropolitan Elevated preferred	58
National Carbon common	62
National Carbon preferred	114
Union Traction common	6
Union Traction preferred	34

Northwestern Elevated's daily average of passengers for May was 77,863, an increase of 8,631.

Oak Park Elevated for May showed a daily average, including transfers, of 46,471 passengers, an increase of 3,638.

Metropolitan Elevated for May carried an average of 125,164 passengers, an increase of 10,792, making the best showing since 1903.

South Side Elevated's May daily average of traffic was 89,971, an increase of 6,629.

ENGINEERING SOCIETIES.

TORONTO BRANCH OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—The twenty-first regular meeting of the Toronto branch of the American Institute of Electrical Engineers was held on May 26, 1905. Prof. Rosebrugh presented a paper entitled "Armature Winding," which was illustrated with lantern slides. Officers were also elected for the ensuing year.

INDUSTRIAL ITEMS.

THE INTERNATIONAL NICKEL COMPANY, 43 Exchange place, New York city, has issued a small pamphlet giving a list of uses to which nickel-steel may be put.

THE ELECTRIC COMPANY, Continental Building, Baltimore, Md., has issued a catalogue of electric fans. This contains a large number of different types of fans, including desk fans, swivel fans, ceiling fans, electrolier fans, revolving fans, etc.

THE BROWN & SHARPE MANUFACTURING COMPANY, Providence, R. I., is calling attention to its new machinists' tools. These include micrometer caliper sets, improved steel beam trammels, universal dividers, scribers, straight edges, etc.

THE NOVELTY ELECTRIC COMPANY, Philadelphia, Pa., is calling attention, in a very handsome catalogue, to the "Neco" battery call telephone which it manufactures. This catalogue describes desk sets, wall sets, bracket sets and different forms of annunciators.

THE BROWNING ENGINEERING COMPANY, Cleveland, Ohio, in bulletin No. 17 describes and illustrates the "Browning Square Type" automatic grab-bucket for digging coal, ashes, cinders, coke, gravel, sand, crushed stone, slag, and for all materials of a similar character.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., reports that it has closed contracts for switchboards for the following places: Quimby, Ohio; Rice Lake, Wis.; Roosevelt, Ariz.; Essex, Iowa; Breeds, Ill.; Linn Grove, Iowa; Buffalo Hart, Ill.; Baldwin, Wis.

THE ECONOMICAL ELECTRIC LAMP COMPANY, 227-229 Fulton street, New York city, is calling attention to the "Economical" turndown lamp. This lamp is furnished in all voltages from 50 to 240, and with Westinghouse, Edison and Thomson-Houston bases. The manufacturer states that "it turns up and down like gas."

THE NERNST LAMP COMPANY, Pittsburg, Pa., is distributing two handsome bulletins entitled, respectively, "Church Lighting by Electricity" and "Bank and Office Lighting by Electricity." There is also a general catalogue and price list, No. 4. This supersedes all previous price lists, and should be secured by every one interested.

E. C. HOGREVE & COMPANY, 642 Main street, Cincinnati, Ohio, are distributing a folder describing and illustrating interior telephones for stores, factories, hotels, warehouses, etc. The instruments shown are intercommunicating sets, desk sets, single-line telephones, party-line telephones, hotel telephones and hotel annunciators.

DODGE & DAY, Philadelphia, Pa., have been commissioned by the Electro-Dynamic Company to make a thorough examination of the existing methods in the shops at Bayonne, N. J. The business of the Electro-Dynamic Company has increased to such an extent that it has become urgently necessary either to speed up the shops or provide more adequate facilities.

THE STANLEY INSTRUMENT COMPANY, Great Barrington, Mass., is advertising its rotated jewel-bearing wattmeters for alternating-current circuits by means of a large blotter, upon the back of which is shown a wattmeter, together with a large amount of descriptive matter concerning it. The company has also issued bulletin No. 90531, descriptive of the same instrument.

THE F. BISSELL COMPANY, Toledo, Ohio, reports that it is doing a large business in poles. The demand is heavy, and the supply is none too plentiful for actual stocks. The company is filling orders rapidly, and suggests that those who intend purchasing this year should not defer longer than necessary, as all indications point to a shortage, particularly in sizes of thirty-five feet and upward.

FRANK B. GILBRETH, 34 West Twenty-sixth street, New York city, announces that he has received a contract, on the cost plus-fixed sum basis, for a large car barn, 76 by 361 feet, at North Syracuse, N. Y. The architects, Messrs. Gaggin & Gaggin, have decided that, instead of the conventional iron roof, a concrete roof shall be used. Besides the car barn the contract calls for the building of a substation 38 by 103 feet.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., has issued a series of leaflets to be inserted in its perpetual catalogue. It must be understood that these bulletins replace older ones similarly designated. These older bulletins should be removed from the perpetual catalogue, and the new ones put in their place. The company will be pleased to send these bulletins to any one who is interested.

THE NATIONAL CONDUIT AND CABLE COMPANY, 41 Park Row, New York, in a pamphlet, entitled "Copper Gossip," discusses the business outlook and the copper market situation. Conditions are stated to be favorable, and the copper market is firmer and more active. The exports for the first four months break all records. The pamphlet also gives a comparison of the price of copper at London and New York for the past six weeks, the exports and imports of copper for the first part of 1905, and European copper statistics.

THE CHANDLER & TAYLOR COMPANY, Indianapolis, Ind., will be pleased to send bulletin No. E-101, descriptive of standard service enclosed, self-oiling, direct-connected engines. The engines illustrated in this bulletin are built strictly in accordance with the recommendations of the joint committee of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, as to speeds, sizes of units and sizes of shafts. In addition to the text describing the engines, there are several illustrations which make evident the construction of the machines.

THE CHICAGO FUSE WIRE AND MANUFACTURING COMPANY, 203 Fulton street, New York city, is distributing bulletin No. 16, describing "Union" enclosed fuses and blocks. This system of fuses has been perfected after several years of experimental work, and now includes the styles known as "National Code Standard," and, in addition, fuses in sizes to fit other styles of blocks in common use, as well as a large variety of switchboard fuses of all sizes. "Union" code blocks are made of highest grade electrical porcelain, with mountings of heavy brass and phosphor-bronze springs.

H. M. BYLLESBY & COMPANY, INCORPORATED, engineers, New York Life Building, Chicago, Ill., have issued bulletin No. 2. This is entitled "Economy Test of a 500-Kilowatt Steam Turbine for Oshkosh Gas Light Company, Oshkosh, Wis." The results obtained in the tests are most interesting. The steam consumption ranged from 25.99 pounds per kilowatt-hour at half load (250 kilowatts) to 22.28 pounds per kilowatt-hour with an overload of 22.2 per cent, or 611 kilowatts. The complete results of the tests are given in tabulated form for half-load runs, commercial runs, full and overload runs. In addition to the tables the test results are plotted on cross-section paper. The bulletin is a most valuable addition to steam turbine literature.

THE ELECTRO-DYNAMIC COMPANY, Bayonne, N. J., will have an exhibit on the veranda of the Manhattan Beach Hotel during the convention of the American Railway Master Mechanics' Association and the Master Car Builders, which will be held at Manhattan Beach, L. I., N. Y., June 14 to 21. The exhibit will consist of one of the company's type "5-S" four to one "Interpole" variable-speed motors belted to a generator. This motor will also be reversed under all of the different conditions of load and speed, and will show remarkable results in the operation of electric motors, either for constant or variable-speed work. There will also be on exhibition varieties of motors, running from one horse-power at a speed ratio of four to one, up to ten horse-power at a speed ratio of four to one. The motors which the company will exhibit at Manhattan Beach will cover 123 distinct varieties, enabling the user of motors a remarkable opportunity for selection. The company is rapidly enlarging its scope of operation, and within the next ninety days will be prepared to sell at least 200 varieties of constant and variable-speed motors running up as high as 150 horse-power. In addition to this exhibit, one of the company's "5-S" variable-speed motors having a speed ratio of four to one will operate the electric car-lighting equipment of the Consolidated Railway, Electric Lighting and Equipment Company.